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MARY SOMERVILLE.

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THE SINS OF LEGISLATORS.

By HERBERT SPENCER.

BE it or be it not true that man is "shapen in iniquity" and conceived in sin, it is unquestionably true that Government is begotten of aggression and by aggression. In small, undeveloped societies where for ages complete peace has continued, there exists nothing like what we call Government: no coercive agency, but mere honorary headship, if any headship at all. In these exceptional communities, unaggressive and from special causes unaggressed upon, there is so little deviation from the virtues of truthfulness, honesty, justice, and generosity, that nothing beyond an occasional expression of public opinion by informally-assembled elders is needful.* Conversely, we find proofs that, at first recognized but temporarily during leadership in war, the authority of a chief is permanently established by continuity of war; and grows strong where successful aggression ends in subjection of neighboring tribes. And thence onward, examples furnished by all races put beyond doubt the truth that the coercive power of the chief, developing into king, and king of kings (a frequent title in the ancient East), becomes great in proportion as conquest becomes habitual and the union of subdued societies extensive.† Comparisons disclose a further truth which should be ever present to us—the truth that the aggressiveness of the ruling power inside a society increases with its aggressiveness outside the society. As, to make an efficient army, the soldiers in their several grades must be subordinate to the commander; so, to make an efficient fighting society, must the citizens be subordinate. They must furnish recruits to the extent demanded, and yield up whatever property is required.

* "Political Institutions," §§ 437, 573.

† Ibid., §§ 471–473.

An obvious implication is that the ethics of Government, originally identical with the ethics of war, must long remain akin to them; and can diverge from them only as warlike activities and preparations become less. Current evidence shows this. At present on the Continent, the citizen is free only when his services as a soldier are not demanded; and during the rest of his life he is largely enslaved in supporting the military organization. Even among ourselves, a serious war would, by the necessitated conscription, suspend the liberties of large numbers and trench on the liberties of the rest by taking from them through taxes whatever supplies were needed—that is, forcing them to labor so many days more for the state. Inevitably the established code of conduct in the dealings of Governments with citizens must be allied to their code of conduct in their dealings with one another.

I am not, under the title of this article, about to treat of the trespasses and the revenges for trespasses, accounts of which constitute the great mass of history; nor to trace the internal inequities which have ever accompanied the external inequities. I do not propose here to catalogue the crimes of irresponsible legislators, beginning with that of King Khufu, the stones of whose vast tomb were laid in the bloody sweat of tens of thousands of slaves toiling through long years under the lash; going on to those committed by conquerors, Egyptian, Assyrian, Persian, Macedonian, Roman, and the rest; and ending with those of Napoleon, whose ambition to set his foot on the neck of the civilized world cost not less than two million lives.* Nor do I propose here to enumerate those sins of responsible legislators seen in the long list of laws made in the interests of dominant classes—a list coming down in our own country to those under which there were long maintained slavery and the slave-trade, inflicting on immense numbers of negroes the horrors of "the middle passage" and killing thirty per cent of them, and ending with that of the corn laws, by which, says Sir Erskine May, "to insure high rents, it had been decreed that multitudes should hunger." †

Not, indeed, that a presentation of the conspicuous misdeeds of legislators, responsible and irresponsible, would be useless. It would have several uses—one of them relevant to the truth above pointed out. Such a presentation would make clear how that identity of governmental ethics with military ethics which necessarily exists during primitive times, when the army is simply the mobilized society and the society is the quiescent army, continues through long stages, and even now affects in great degrees our law-proceedings and our daily lives. Having, for instance, shown that in numerous savage tribes the judicial function of the chief does not exist, or is nominal, and that very generally in early stages of the civilized races each man had to defend himself, and rectify his private wrongs as best he might—hav-

* "Study of Sociology," p. 42. † "Constitutional History of England," ii, p. 617.

ing shown that in mediæval Europe the right of private war among members of the military order was brought to an end, not because the head ruler thought it his duty to arbitrate, but because private wars interfered with the efficiency of his army in public wars—having shown that the administration of justice long continued to display in large measure its primitive nature in trial by battle, carried on before the king or his deputy as umpire, and which among ourselves continued nominally to be an alternative form of trial down to 1819, it might then be pointed out that even now there survives trial by battle under another form: counsel being the champions and purses the weapons. In civil cases the ruling agency cares scarcely more than of old about rectifying the wrongs of the injured; but, practically, its deputy does little more than to enforce the rules of the fight: the result being less a question of equity than a question of pecuniary ability and forensic skill. Nay, so little concern for the administration of justice is shown by the ruling agency, that when, by legal conflict carried on in presence of its deputy, the combatants have been pecuniarily bled even to the extent of producing prostration, and when, an appeal being made by one of them, the decision is reversed, the beaten combatant is made to pay for the blunders of the deputy or a preceding deputy; and not unfrequently the wronged man, who sought protection or restitution, is taken out of court pecuniarily dead.

Adequately done, such a portrayal of governmental misdeeds of commission and omission, proving that the partially surviving code of ethics arising in and proper to a state of war still vitiates governmental action, might greatly moderate the hopes of those who are anxious to extend governmental control.

But leaving out the greater part of the large topic comprehended under the title of this article, I propose here to deal only with a comparatively small remaining part—those sins of legislators which are not generated by personal ambitions or class interests, but result from a lack of the study by which legislators are morally bound to prepare themselves.

A druggist's assistant who, after listening to the description of pains which he mistakes for those of colic, but which are really caused by inflammation of the cæcum, prescribes a sharp purgative and kills the patient, is found guilty of manslaughter. He is not allowed to excuse himself on the ground that he did not intend harm, but hoped for good. The plea that he simply made a mistake in his diagnosis is not entertained. He is told that he had no right to risk disastrous consequences by meddling in a matter concerning which his knowledge was so inadequate. The fact that he was ignorant how great was his ignorance is not accepted in bar of judgment. It is tacitly assumed that the experience common to all should have taught him that even the skilled, and much more the unskilled, are liable to mistakes in the identification of disorders and in the appropriate treatment; and that, having disregarded the warning derivable from common experience, he was answerable for the consequences.

We measure the responsibilities of legislators for mischiefs they may do, in a much more lenient fashion. In most cases, so far from thinking of them as deserving any kind of punishment for causing disasters by laws ignorantly enacted, we scarcely think of them as deserving reprobation. It is held that common experience should have taught the druggist's assistant, untrained as he is, not to interfere; but it is not held that common experience should have taught the legislator not to interfere till he has trained himself. Though multitudinous facts are before him in the recorded legislation of our own country and of other countries, which should impress on him the immense evils caused by wrong treatment, he is not condemned for disregarding these warnings against rash meddling. Contrariwise, it is thought meritorious in him when—perhaps lately from college, perhaps fresh from keeping a pack of hounds which made him popular in his county, perhaps emerging from a provincial town where he acquired a fortune, perhaps rising from the bar at which he has gained a name as an advocate—he enters Parliament, and forthwith, in quite a light-hearted way, begins to aid or hinder this or that means of operating on the body politic. In this case, there is no occasion even to make for him the excuse that he does not know how little he knows; for the public at large agrees with him in thinking it needless that he should know anything more than what the debates on the proposed measures tell him.

And yet the mischiefs wrought by uninstructed law-making, vast in their amount as compared with those caused by uninstructed medical treatment, are conspicuous to all who do but glance over its history. The reader must pardon me while I recall a few familiar instances. Century after century statesmen went on enacting usury laws which made worse the condition of the debtor—raising the rate of interest "from five to six when intending to reduce it to four," * as under Louis XV; and producing undreamed-of evils of an indirect kind, such as preventing the reproductive use of spare capital, and "burdening the small proprietors with a multitude of perpetual services." † So, too, the endeavors which in England continued through five hundred years to stop forestalling, and which in France, as Arthur Young witnessed, prevented any one from buying "more than two bushels of wheat at market," ‡ went on generation after generation, increasing the miseries and mortality due to dearth; for, as everybody now knows, the wholesale dealer, who was in the statute "De Pistori-

* Lecky, "Rationalism," ii, pp. 293, 294.

† De Tocqueville, "The State of Society in France before the Revolution," p. 421.

‡ Young's "Travels," i, pp. 128, 129.

bus" vituperated as "an open oppressor of poor people," * is simply one whose function it is to equalize the supply of a commodity by checking unduly rapid consumption. Of kindred nature was the measure which, in 1315, to diminish the pressure of famine, prescribed the prices of foods, but which was hastily repealed after it had caused entire disappearance of various foods from the markets; and also such measures, more continuously operating, as those which settled by magisterial order "the reasonable gains" of victualers. † Of like spirit and followed by allied mischiefs have been the many endeavors to fix wages, which began with the statute of laborers under Edward III, and ceased only sixty years ago; when, having long galvanized in Spitalfields a decaying industry, and fostered there a miserable population, Lords and Commons finally gave up fixing silk-weavers' earnings by magisterial order.

Here I imagine an impatient interruption: "We know all that; the story is stale. The mischiefs of interfering with trade have been dinned in our ears till we are weary; and no one needs to be taught the lesson afresh." My first reply is, that by the great majority the lesson was never properly learned at all, and that very many of those who did learn it have forgotten it. For just the same pleas which of old were put in for these dictations are again put in. In the statute 35 of Edward III, which aimed to keep down the price of herrings (but was soon repealed because it raised the price), it was complained that people "coming to the fair . . . do bargain for herring, and every of them, by malice and envy, increase upon other, and, if one proffer forty shillings, another will proffer ten shillings more, and the third sixty shillings, and so every one surmounteth other in the bargain." ‡ And now the "higgling of the market," here condemned and ascribed to "malice and envy," is being again condemned. The evils of competition have all along been the stock cry of the socialists; and the council of the Democratic Federation denounced the carrying on of exchange under "the control of individual greed and profit." My second reply is, that interferences with the law of supply and demand, which a generation ago were admitted to be habitually mischievous, are now being daily made by acts of Parliament in other fields; and that, as I shall presently show, they are in these fields increasing the evils to be cured and producing new ones, as much as of old they did in fields no longer intruded upon.

Returning from this parenthesis, I go on to explain that the above acts are named to remind the reader that uninstructed legislators have in past times continually increased human suffering in their endeavors to mitigate it; and I have now to add that if these evils, shown to be legislatively intensified or produced, be multiplied by ten or more, a

* Craik's "History of British Commerce," i, p. 134. † Ibid., i, pp. 136, 137.

‡ Craik, *loc. cit.*, i, p. 137.

conception will be formed of the aggregate evils caused by law-making unguided by study of social science. In a paper read to the Statistical Society in May, 1873, by Mr. Janson, Vice-President of the Law Society, it was stated that from the statute of Merton (20 Henry III) to the end of 1872, there had been passed 18,110 public acts, of which he estimated that four fifths had been wholly or partially repealed. He also stated that the number of public acts repealed wholly or partly, or amended, during the three years 1870–'72 had been 3,532, of which 2,759 had been totally repealed. To see whether this rate of repeal has continued, I have referred to the annually-issued volumes of "The Public General Statutes" for the last three sessions. Leaving out amended acts and enumerating only acts entirely repealed, the result is that in the last three sessions there have been repealed separately, or in groups, 650 acts *belonging to the present reign.* This, of course, is greatly above the average rate; for there has of late been an active clearance of the statute-book going on. But, making every allowance, we must infer that within our own times repeals have mounted some distance into the thousands. Doubtless a number of them have been of laws that were obsolete; others have been demanded by changes of circumstances (though seeing how many of them are of quite recent acts this has not been a large cause); others simply because they were inoperative; and others have been consequent on the consolidations of numerous acts into single acts. But unquestionably, in multitudinous cases, repeals came because the acts had proved injurious. We talk glibly of such changes—we think of canceled legislation with indifference. We forget that before laws are abolished they have generally been inflicting evils more or less serious, some for a few years, some for tens of years, some for centuries. Change your vague idea of a bad law into a definite idea of it as an agency operating on people's lives, and you see that it means so much of pain, so much of illness, so much of mortality. A vicious form of legal procedure, for example, either enacted or tolerated, entails on suitors costs, or delay, or defeat. What do these imply? Loss of money, often ill-spared; great and prolonged anxiety; frequently consequent illness; unhappiness of family and dependents; children stinted in food and clothing—all of them miseries which bring after them multitudinous remoter miseries. Add to which there are the far more numerous cases of those who, lacking the means or the courage to enter on lawsuits, and submitting to frauds, are impoverished, and have similarly to bear the pains of body and mind which ensue. Seeing, then, that bad legislation means injury to men's lives, judge what must be the total amount of mental distress, physical pain, and raised mortality which these thousands of repealed acts of Parliament represent! Fully to bring home the truth that law-making unguided by adequate knowledge brings immense evils, let me take a special case which a question of the day brings before us.

Already I have hinted that interferences with the connection between supply and demand, given up in certain fields after immense mischiefs had been done during many centuries, are now taking place in other fields. This connection is supposed to hold only where it has been proved to hold by the evils of disregarding it : so feeble is men's belief in it. There seems no suspicion that, in cases where it seems to fail, it is because it has been traversed by artificial hindrances. And yet in the case to which I now refer—that of the supply of houses for the poor—it needs but to ask what laws have been doing for a long time past, to see that the terrible evils complained of are mostly law-made.

A generation ago discussion was taking place concerning the inadequacy and badness of industrial dwellings, and I had occasion to deal with the question. Here is a passage then written :

An architect and surveyor describes it [the Building Act] as having worked after the following manner : In those districts of London consisting of inferior houses, built in that unsubstantial fashion which the New Building Act was to mend, there obtains an average rent, sufficiently remunerative to landlords whose houses were run up economically before the New Building Act passed. This existing average rent fixes the rent that must be charged in these districts for new houses of the same accommodation—that is, the same number of rooms, for the people they are built for do not appreciate the extra safety of living within walls strengthened with hoop-iron bond. Now, it turns out upon trial, that houses built in accordance with the present regulations, and let at this established rate, bring in nothing like a reasonable return. Builders have consequently confined themselves to erecting houses in better districts (where the possibility of a profitable competition with pre-existing houses shows that those pre-existing houses were tolerably substantial), and have ceased to erect dwellings for the masses, except in the suburbs where no pressing sanitary evils exist. Meanwhile, in the inferior districts above described, has resulted an increase of overcrowding—half a dozen families in a house, a score lodgers to a room. Nay, more than this has resulted. That state of miserable dilapidation into which these abodes of the poor are allowed to fall is due to the absence of competition from new houses. Landlords do not find their tenants tempted away by the offer of better accommodation. Repairs, being unnecessary for securing the largest amount of profit, are not made. . . . In fact, for a large percentage of the very horrors which our sanitary agitators are now trying to cure by law, we have to thank previous agitators of the same school !—" Social Statics," p. 384 (first edition).

These were not the only law-made causes of such evils. As shown in the following further passage, sundry others were recognized :

Writing before the repeal of the brick-duty, " The Builder " says: " It is supposed that one fourth of the cost of a dwelling which lets for 2*s.* 6*d.* or 3*s.* a week is caused by the expense of the title-deeds and the tax on wood and bricks used in its construction. Of course, the owner of such property must be remunerated, and he therefore charges 7½*d.* or 9*d.* a week to cover these burdens." M. C. Gatliff, secretary to the Society for Improving the Dwellings of the Working-Classes, describing the effect of the window-tax, says: " They are now paying upon their institution in St. Pancras the sum of £162 16*s.* in window-duties, or one per cent per annum upon the original outlay. The average rental paid by the society's tenants is 5*s.* 6*d.* per week, and the window-duty deducts from this 7½*d.* per week."—"Times," January 31, 1850. "Social Statics," p. 386 (original edition).

Neither is this all the evidence which the press of those days afforded. There was published in the "Times" of December 7, 1850 (too late to be used in the above-named work, which I issued in the last week of that year), a letter dated from the Reform Club, and signed "Architect," which contained the following passages:

Lord Kinnaird recommends in your paper of yesterday the construction of model lodging-houses by throwing two or three houses into one.

Allow me to suggest to his lordship, and his friend Lord Ashley to whom he refers, that if—

1. The window-tax were repealed;
2. The Building Act repealed (excepting the clauses enacting that party and external walls shall be fire-proof);
3. The timber duties either equalized or repealed; and
4. An act passed to facilitate the transfer of property—

There would be no more necessity for model lodging-houses than there is for model ships, model cotton-mills, or model steam-engines.

The first limits the poor man's house to seven windows.

The second limits the size of the poor man's house to twenty-five feet by eighteen (about the size of a gentleman's dining-room), into which space the builder has to cram a staircase, an entrance-passage, a parlor, and a kitchen (walls and partitions included).

The third induces the builder to erect the poor man's house of timber unfit for building purposes, the duty on the good material (Baltic) being fifteen times more than the duty on the bad or injurious article (Canadian). The Government, even, exclude the latter from all their contracts.

The fourth would have considerable influence upon the present miserable state of the dwellings of the poor. Small freeholds might then be transferred as easily as leaseholds. The effect of building-leases has been a direct inducement to bad building.

To guard against misstatement or overstatement, I have taken the precaution to consult a large East-End builder and contractor of fifty-five years' experience, Mr. C. Forrest, Museum Works, 17 Victoria Park Square, Bethnal Green, who, being church-warden, member of the vestry, and of the board of guardians, adds extensive knowledge of local public affairs to his extensive knowledge of the building business. Mr. Forrest, who authorizes me to give his name, verifies the foregoing statements with the exception of one, which he strengthens. He says that "Architect" understates the evil entailed by the definition of "a fourth-rate house"; since the dimensions are less than those he gives (perhaps in conformity with the provisions of a more recent Building Act). Mr. Forrest has done more than this. Besides illustrating the bad effects of great increase in ground-rents (in sixty years, from £1 to £8 10*s.* for a fourth-rate house), which, joined with other causes, had obliged him to abandon plans for industrial dwellings he had intended to build—besides agreeing with "Architect" that this evil has been greatly increased by the difficulties of land-transfer due to the law-established system of trusts and entails, he pointed out that a further penalty on the building of small houses is inflicted by additions to local burdens ("prohibitory imposts" he called them): one of the instances he named being, that to the cost of each new house has to be added the cost of pavement, roadway, and sewerage, which is charged according to length of frontage, and which, consequently, bears a far larger ratio to the value of a small house than to the value of a large one.

From these law-produced mischiefs, which were great a generation ago and have since been increasing, let us pass to more recent law-produced mischiefs. The misery, the disease, the mortality in "rookeries," made continually worse by artificial impediments to the increase of fourth-rate houses, and by the necessitated greater crowding of those which existed, having become a scandal, Government was invoked to remove the evil. It responded by Artisans' Dwellings Acts; giving to local authorities powers to pull down bad houses and provide for the building of good ones. What have been the results? A summary of the operations of the Metropolitan Board of Works, dated December 21, 1883, shows that up to last September it had, at a cost of a million and a quarter to rate-payers, unhoused 21,000 persons and provided houses for 12,000—the remaining 9,000 to be hereafter provided for being, meanwhile, left houseless. This is not all. Another local lieutenant of the Government, the Corporation of London, working on the same lines, has cleared four spaces amounting to several acres; but has unhappily failed to get them covered with the substituted houses needed, and has thus added a further thousand or two to those who have to seek homes in miserable places that are already overflowing!

See, then, what legislation has done. By ill-imposed taxation, raising the prices of bricks and timber, it added to the cost of houses, and prompted, for economy's sake, the use of bad materials in scanty quantities. To check the consequent production of wretched dwellings, it established regulations which, in mediæval fashion, dictated the quality of the commodity produced: there being no perception that, by insisting on a higher quality and therefore higher price, it would limit the demand and eventually diminish the supply. By additional local burdens, legislation has of late still further hindered the building of small houses. Finally, having, by successive measures, produced first bad houses and then a deficiency of better ones, it has at length provided for the increasing overflow of poor people by diminishing the house capacity which already could not contain them!

Where, then, lies the blame for the crying evils of the East-

End? Against whom should be raised "the bitter cry of outcast London"?

The German anthropologist, Bastian, tells us that a sick native of Guinea who causes the fetich to lie by not recovering is strangled;* and we may reasonably suppose that among the Guinea people any one audacious enough to call in question the power of the fetich would be promptly sacrificed. In days when governmental authority was enforced by strong measures, there was a kindred danger in saying anything disrespectful of the political fetich. Nowadays, however, the worst punishment to be looked for by one who questions its omnipotence is that he will be reviled as a reactionary who talks *laissez-faire.* That any facts he may bring forward will appreciably decrease the established faith is not to be expected; for we are daily shown that this faith is proof against all adverse evidence. Let us contemplate a small part of that vast mass of it which passes unheeded.

"A Government office is like an inverted filter; you send in accounts clear and they come out muddy." Such was the comparison I heard made many years ago by the late Sir Charles Fox, who, in the conduct of his business, had considerable experience of public departments. That his opinion was not a singular one, though his comparison was, all men know. Exposures by the press and criticisms in Parliament leave no one in ignorance of the vices of red-tape routine. Its delays, perpetually complained of, and which in the time of Mr. Fox Maule went to the extent that "the commissions of officers in the army" were generally "about two years in arrear," is afresh illustrated by the issue of the first volume of the detailed census of 1881, more than two years after the information was collected. If we seek explanations of such delays, we find one origin to be a scarcely credible confusion. In the case of the delayed census returns, the registrar-general tells us that "the difficulty consists not merely in the vast multitude of different areas that have to be taken into account, but still more in the bewildering complexity of their boundaries": there being thirty-nine thousand administrative areas of twenty-two different kinds which overlap one another—hundreds, petty sessional divisions, lieutenancy divisions, urban and rural sanitary districts, unions, school-board districts, school-attendance districts, etc. And then, as Mr. W. Rathbone points out,† these many superposed sets of areas, with intersecting boundaries, have their respective governing bodies with authorities running into one another's districts. Does any one ask why for each additional administration Parliament has established a fresh set of divisions? The reply which suggests itself is, To preserve consistency of method. For this organized confusion harmonizes completely with that organized confusion which Parliament each year increases by throwing on to the heap of its old acts a hundred new acts,

* "Mensch," iii, p. 225. † "The Nineteenth Century," February, 1883.

the provisions of which traverse and qualify in all kinds of ways the provisions of multitudinous acts on to which they are thrown: the onus of settling what is the law being left to private persons, who lose their property in getting judges' interpretations. And again this system of putting networks of districts over other networks, with their conflicting authorities, is quite consistent with the method under which the reader of the Public Health Act of 1872, who wishes to know what are the powers exercised over him, is referred to twenty-six preceding acts of several classes and numerous dates.* So, too, with administrative inertia. Continually there occur cases showing the resistance of officialism to improvements: as by the Admiralty when use of the electric telegraph was proposed, and the reply was, "We have a very good semaphore system"; or as by the Post-Office, which the late Sir William Siemens years ago said had obstructed the employment of improved methods of telegraphing, and since then has impeded the general use of the telephone. Other cases, akin to that above set forth in detail, now and then show how the state with one hand increases evils which with the other hand it tries to diminish: as when it puts a duty on fire-insurances and then makes regulations for the better putting out of fires; dictating, too, certain modes of construction, which, as Captain Shaw shows, entail additional dangers.† Again, the absurdities of official routine, rigid where it need not be and lax where it should be rigid, occasionally become glaring enough to cause scandals: as when a secret state document of importance put into the hands of an ill-paid copying-clerk, who is not even in permanent Government employ, is made public by him; or as when the mode of making the Moorsom fuse, which was kept secret even from our highest artillery-officers, was taught to them by the Russians, who had been allowed to learn it; or as when a diagram showing the "distances at which British and foreign ironclads could be perforated by our large guns," communicated by an enterprising *attaché* to his own Government, then became known "to all the Governments of Europe," while English officers remained ignorant of the facts.‡ So, too, with state-supervision. From time to time it is pointed out that coal-mine explosions continue notwithstanding coal-mine inspection: the only effect being that more inspection and more stringent regulations are demanded. Even where the failure of inspection is most glaring, no notice is taken of it; as instance the terrible catastrophe by which a train full of people was destroyed along with the Tay Bridge. Countless denunciations, loud and unsparing, were vented against engineer and contractor; but little, if anything, was said about the government officer from whom the

* "The Statistics of Legislation." By F. H. Janson, Esq., F. L. S., Vice-President of the Incorporated Law Society. (Read before the Statistical Society, May, 1873.)

† "Fire Surveys; or, a Summary of the Principles to be observed in estimating the Risk of Buildings."

‡ See "Times," October 6, 1874, where other instances are given.

bridge received state-approval. So too with prevention of disease. It matters not that under the management or dictation of state-agents some of the worst evils occur: as when the lives of eighty-seven wives and children of soldiers are sacrificed in the ship Accrington;* or as when typhoid fever and diphtheria are diffused by a state-ordered drainage system, as in Edinburgh;† or as when officially-enforced sanitary appliances, ever getting out of order, increase the evils they were to decrease.‡ These and multitudinous such facts leave unabated the confidence with which sanitary inspection is invoked—invoked, indeed, more than ever, as is shown in the recent suggestion that all public schools should be under the supervision of health-officers. Nay, even when the state has manifestly caused the mischief complained of, faith in its beneficent agency is not at all diminished; as we see in the fact that, having a generation ago authorized, or rather required, towns to establish drainage systems which delivered sewage into the rivers, and having thus polluted the sources of water-supply, the water-companies have come to be daily denounced for the impurities of their water; and, as the only remedy, there follows the demand that the state by its local proxies shall undertake the whole business. The state's misdoings become, as in the case of industrial dwellings, reasons for praying it to do more.

This work of the Legislature is, in one respect, indeed, less excusable than the fetich-worship to which I have tactily compared it. The savage has the defense that his fetich is silent—does not confess its inability. But the civilized man persists in ascribing to this idol, made with his own hands, powers which in one way or other it confesses it has not got. I do not mean merely that the debates daily tell us of legislative measures which have done evil instead of good; nor do I mean merely that the thousands of acts of Parliament which repeal preceding acts are so many tacit admissions of failure. Neither do I refer only to such *quasi*-governmental confessions as that contained in the report of the Poor-Law Commissioners, who said that "we find, on the one hand, that there is scarcely one statute connected with the administration of public relief which has produced the effect designed by the Legislature, and that the majority of them have created new evils, and aggravated those which they were intended to prevent." I refer rather to those made by statesmen, and by state-departments. Here, for example, in a memorial addressed to Mr. Gladstone, and

* Hansard, vol. clvi, p. 718, and vol. clvii, p. 4464.

† Letter of an Edinburgh M. D. in the "Times" of January 17, 1876, verifying other testimonies: one of which I have previously cited concerning Windsor, where, as in Edinburgh, there was absolutely no typhoid in the undrained parts, while it was very fatal in the drained parts.—"Study of Sociology," chap. i, notes.

‡ I say this partly from personal knowledge; having now before me memoranda made twenty-five years ago concerniug such results produced under my own observation. Verifying facts have recently been given by Sir Richard Cross in the "Nineteenth Century" for January, 1884, p. 155.

adopted by a highly influential meeting held under the chairmanship of the late Lord Lyttelton, I read:

> We, the undersigned, peers, members of the House of Commons, rate-payers, and inhabitants of the metropolis, feeling strongly the truth and force of your statement made in the House of Commons, in 1866, that "there is still a lamentable and deplorable state of our whole arrangements, with regard to public works—vacillation, uncertainty, costliness, extravagance, meanness, and all the conflicting vices that could be enumerated, are united in our present system," etc., etc.*

And here again is an example furnished by a recent minute of the Board of Trade (November, 1883), in which it is said that since "the Shipwreck Committee of 1836 scarcely a session has passed without some act being passed or some step being taken by the Legislature or the Government with this object" (prevention of shipwreck); and that "the multiplicity of statutes, which were all consolidated into one act in 1854, has again become a scandal and a reproach"—each measure being passed because previous ones had failed. And then comes presently the confession that "the loss of life and of ships has been greater since 1876 than it ever was before." Meanwhile, the cost of administration has been raised from £17,000 a year to £73,000 a year.†

It is surprising how, spite of better knowledge, the imagination is affected by artificial appliances used in particular ways. We see it all through human history, from the war-paint with which the savage frightens his adversary, down through religious ceremonies and regal processions, to the robes of a Speaker and the wand of an officially-dressed usher. I remember a child who, able to look with tolerable composure on a horrible cadaverous mask while it was held in the hand, ran away shrieking when his father put it on. A kindred change of feeling comes over constituencies when, from boroughs and counties, their members pass to the legislative chamber. While before them as candidates, they are, by one or other party, jeered at, lampooned, "heckled," and in all ways treated with utter disrespect. But, as soon as they assemble at Westminster, those against whom taunt and invective, charges of incompetence and folly, had been showered from press and platform, excite unlimited faith. Judging from the prayers made to them, there is nothing which their wisdom and their power can not compass.

* The "Times," March 31, 1873.

† These are just a few additional examples. Masses of those which I have on earlier occasions given will be found in "Social Statics" (1851); "Over-Legislation" (1853); "Representative Government" (1857); "Specialized Administration" (1871); "Study of Sociology" (1873), and Postscript to ditto (1880); besides some cases in smaller essays.

[*To be continued.*]

THE BEAVER AND HIS WORKS.

By Dr. G. ARCHIE STOCKWELL.

THANKS to the decrease of castor in value, owing to the substitutes which have been found in the skins of seal, nutria—the improved preparation of other peltry of little value, such as the hare and rabbit—and more than all in the use of silk in the manufacture of hats, a little breathing-time has been allowed the beaver, which a few years since bade fair to speedily become extinct.

Formerly inhabiting every part of North America possessed of forest-growth, at present it is found only in the wilder and least accessible regions of the continent. At the time the reindeer, musk-ox, mammoth, and rhinoceros roamed the temperate zone, beaver were abundant, and filled the country on every hand, from the Mexican Gulf to the Barren Grounds, with their works—wondrous monuments of patience and industry. Perhaps their fur helped to clothe the ignorant savage that eked out a precarious existence by means of game killed with flint-tipped arrows and javelins, and dismembered and divided by hatchets and knives of stone. Doubtless the broad tails were then, as now, esteemed delicate tidbits. And the wondrous instinct displayed may possibly have taught the primeval dweller the rudiments of architecture now exemplified in beautiful structures of wood and stone; for to this day we find some tribes, low in the scale of humanity and civilization, such as the Fischer Lapps and natives of Terra del Fuego, living in huts that, save in point of size, are exact counterparts of the dwellings of the beaver.

Of all quadrupeds, the beaver is one of the most peculiar and interesting. He is the only one that possesses membranes between the toes of the hind-feet, at the same time none on the fore ones—in fact, resembling a terrestrial mammal in front, and an aquatic one behind. When full grown, he exhibits a thick, heavy body over two feet in length, and from thirty to fifty pounds' weight, terminating in a full, compact, cat-like head, with heavy jaws provided with wondrous muscular development. The tail is oval, resembling closely the blade of a paddle, twelve or fourteen inches in length, and four or five in breadth, flattened both above and below, and covered with a thick dusky skin that at first glance appears to be protected by scales. The old writers were accustomed to tell us that this peculiar appendage was used as a trowel for plastering his dwelling or repairing his dam, as a maul for driving stakes, and as a vehicle for transporting loads. But modern science has proved the fallacy of such statements, and we now know that it serves but as a prop or fifth leg when sitting at work, or as scull and rudder while navigating the waters.

Generally, beaver are nocturnal in habits, mild and tranquil in disposition, but not inclined to be social except among immediate relatives. They are also the perfection of neatness and cleanliness, possessed of very acute sight, hearing, and smell; and, when domesticated, very interesting and even affectionate pets.

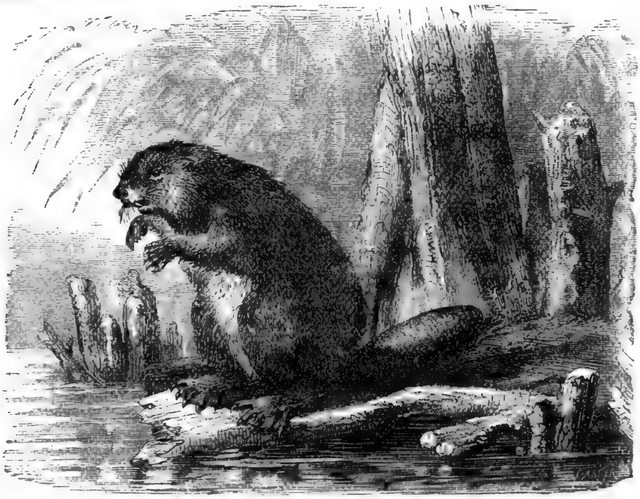

Fig. 1.—The Beaver.

During the summer they are more inclined to solitary habits, except where a new settlement demands their energies; but in autumn they appear in families, which remain unbroken until the following spring. About the middle of August the busy season begins, and each and every one, both great and small, assist in repairing the dam and dwellings, which for some months have been allowed to fall into neglect and unrepair. Trees are felled and cut into suitable lengths, and, along with stones and clods, dragged laboriously to the scene of labor until all is made again secure against ice and cold. Other trees, such as larch, willow, birch, and aspens, are cut up into billets and twigs, and stored for the food their bark affords, against possible want. Their perseverance in this work, the labor expended, and the strength of teeth and jaws, may be fairly estimated by the stumps that remain, as they are found of all diameters, from the smallest brush-wood to growths a foot or more in diameter. I have seen stumps that measured but a fraction less than sixteen inches.

It is with the front or incisor teeth that the cutting is done, and they are eminently adapted to the work, being long, square-crowned, and with edges beveled in the same way as is the carpenter's chisel known as a "firmer"; and the rapidity with which the work is performed may well astonish one who is fortunate enough to witness their proceedings.

Commencing at a height of twelve or fourteen inches from the ground, a distance easily reached while sitting upon the tail and haunches, the tree is gouged around in a complete circle, equally on all sides, but gradually growing deeper and deeper with each circuit, forming, as it were, two cones whose points meet at a common center. When the space chipped out proves too narrow to admit the head, the teeth are applied above and below, as the woodman plies his axe, until the desired result is obtained. Steadily and faithfully he labors, rarely resting, and then but to take a refreshing bath in the nearest pool. At the last he frequently pauses, and, erecting himself upon his hind-legs, feels the trunk with his paws, as if to determine which way it shall fall, or whether it shows any signs of yielding; finally, when perhaps but an inch or two of the heart remain uncut, he gnaws vigorously upon the side toward which he desires it to fall, and, as the warning crack is heard, whips himself with great celerity and adroitness to the opposite side to avoid being crushed in its descent. Next the trunk is divided into lengths, and dragged by aid of teeth, paws, and chin to the water, where it is floated to the dam or storehouse. When large trees are chosen, they almost invariably stand upon the margin of the water, into which they are made to fall; but small growths are frequently sought at considerable distances, and regular paths or "runways" are beaten in the tall grass and ferns where such have been transported. The number of trees felled by one small colony is surprising, and the regularity of the stumps left might lead one unacquainted with the cause to believe them the result of human industry.

When the beaver selects a home on the bank of lake, pond, or stream whose waters are both deep and abundant, dams are rendered unnecessary, and even houses are not always constructed, but instead dwellings are hollowed out from the banks. But on shallow, narrow waters, dams are indispensable in order to secure sufficient depth to allow of concealment and free movement beneath the surface, as well as to prevent obstruction by ice: the entrance to the dwelling or storehouse is always beneath the water, which acts not only as a doorway, but as a safeguard from predatory enemies.

In the building of a dam considerable engineering qualities are developed. It is seldom seen as a mere straight embankment, but goes winding across the stream in graceful curves, bending hither and thither to present its convexity toward the swifter flowing current or deeper waters, taking advantage at the same time of all natural inequalities, now a rock, here an islet, and there a hillock. Trunks of trees are carefully intermingled with clods of earth, stones, and twigs, and every crevice is carefully stopped with mud or clay for greater security; and, when all is finished, the whole presents a structure of almost incredible solidity and compactness, frequently increased by the roots of willow and larch which spring up with all the regularity of a hedge. In the neighborhood of Washington Mine, Lake Superior, may be seen a dam with a total length of fifteen hundred and thirty feet, but the two ends, more than two thirds of the whole, are but natural embankments artfully rendered subservient to the purpose of the beaver by filling in between.

FIG. 2.—BEAVER DAM.

It is these dams that produce those fine tracts of wild grass known as beaver-meadows, upon which cattle and deer so love to feed, and which so frequently furnish the pioneer with the means of subsistence for his stock until he can prepare meadows of his own. Wherever a brook trickled through a wooded valley, there the beaver made his home. Large areas became inundated, the drowned trees fell and decayed, and the freshets brought down new soil from the surrounding hills and ridges. At length the pond filled up and forced the beaver to migrate; the dam unrepaired gradually became shaky and the waters drained off, exposing a rich alluvial soil upon which sprang up waving fields of wild grass. In due time a second growth of timber appeared, and what was once a pond and valley became only a forest bordered by low ridges. In the suburbs of the city of Port Huron, Michigan, may be traced the remains of such a dam, of unknown age and stupendous length. Serpentine in windings, its face may be followed for more than twelve hundred yards ere it becomes indistinct; and doubtless it was originally much longer, as its eastern end has been encroached upon by streets and dwellings. What its height may originally have been can be only a matter of conjecture, as time and the elements have combined to reduce it nearly to a level with the surrounding soil; and its top has given birth and nourishment to mighty trees, long since yielded up to the rapacity of the lumberman, many of whose stumps, half decayed, yet exhibit more than four hundred rings of annular growth. This, too, is but one of a series of five dams upon the same stream grouped in a space of little more than two miles. The Indians have no knowledge or tradition regarding it, though they frequently discovered "stone-wood" (fossil-wood) bearing the marks of beaver-teeth, at the points where the streams forced the barrier.

Of more recent beaver-dams, the writer has examined a few that may be held remarkable. Besides the one near Washington Mine, before mentioned, one on the Ely Branch of the *Ish-ko-naw-ba* (on the maps misspelled *Escanaba*), in the Upper Peninsula of Michigan, giving origin to a pond, with an area of nearly one hundred acres, known as "Grass Lake"; its length is two hundred and sixty feet. A third in the same peninsula, four hundred and eighty feet long, is on Carp River. But the largest is to be found on Sable River, in New Brunswick, and floods upward of one thousand acres of land at an average depth of two feet. Mr. Thompson, whose writings are deemed most authentic, speaking of a dam visited by him in New Brunswick, in 1794, says:

"My guide informed me we should have to pass over a long beaver-dam. I naturally expected to lead our horses carefully over, but on coming to it found a strip of apparently old and solid ground, covered with short grass, and wide enough for two horses to easily walk abreast. The lower side showed a descent of seven feet, and steep, with a rill of water beneath. The side of the dam next the pond was a gentle slope, and the pond itself a sheet of water a mile and a half square, surrounded by low, grassy banks. The trees about were mostly poplars and aspens, with numerous stumps, whose trunks had been cut down and carried away by the beavers." In two places in this pond were observed clusters of houses "like miniature villages."

One is usually disappointed with the first view of a beaver's house. Instead of the symmetrical, round, plastered dome we are led to expect from most popular accounts, there is seen instead an irregular pile of sticks, mingled with rushes, grass, and stones, broad at the base as compared with the height, and of the same general order of architecture as the dam. Apparently devoid of system, it resembles nothing so much as a gigantic crow's nest turned upside down by the border of a pond or stream. And yet, though they are not plastered smoothly, and the interior exhibits but rough walls merely evened by cutting close the twigs that project through in building (the whole affair apparently conceived and put together in a helter-skelter fashion), they are very compact, exhibiting both solidity and firmness, and are well adapted to warmth and protection. Each dwelling consists of but one apartment, and this opens by a short incline beneath the surface of the water into a channel dredged to sufficient depth to avoid being blocked by ice in winter. It is easy to determine whether a dwelling is in present occupation by the appearance of the trails over which the beaver drags his supplies from the wood; by the freshly-peeled sticks the bark of which has served for food, and which are invariably heaped up upon the house itself; and in winter by the melting snow on the roof caused by the exhalations from the occupants.

One dwelling harbors from four to twelve individuals, rarely more, though eighteen or twenty have been noted, all of the same family, but of two generations, representing litters of kittens of two successive years. The young make their appearance usually in May, and are from four to eight in number, five being the average. Queer-looking little fellows they are too, with their heavy heads, big cutting teeth, flat tails, and fine, mouse-like fur, not yet disfigured by the long, coarse hair so noticeable with adults. When taken at an early age they are easily domesticated, and are so esteemed as pets in the far West and fur countries that almost every trading-post or camp can exhibit three or four. It is no uncommon occurrence to see one running about an Indian lodge, submitting patiently to the wiles and caprices of the little savages, or joining in their sports, and frequently receiving with the papoose the nourishment from the maternal breast. The cry of the "kitten," too, is so exactly like that of an unweaned child that one is readily mistaken for the other by even the initiated. On one occasion I visited a wigwam at Little Traverse, Michigan, for the purpose of viewing a "real, live, baby beaver." "He cry all same as papoose," remarked the squaw, as she brought the little fellow forward, at the same time giving him an unmerciful pinch that caused him to set up a doleful little wail that, had I not been forewarned, I should certainly have believed to proceed from a minute, black-eyed specimen of an aboriginal infant that, swathed in cloth, beads, and bark, and bound fast, mummy-like, to a board, stood leaned up against the wall. By-the-way, do Indian babies ever cry or laugh? I suppose they do, occasionally, though I do not remember ever hearing one. I think it is Mr. Lewis Morgan, in his excellent work on "The American Beaver," that tells of a trapper on the upper Yellowstone who, while making his rounds, heard, as he supposed, the wail of an infant. Fearing the vicinity of hostiles, he approached with great caution, only to find that the cry proceeded from two beaver kittens sitting upon a low bank by the stream, and mourning for the nourishment only a mother could give; while she, poor thing, was fast in the merciless jaws of his trap.

When the youngsters have completed their second year, they are unceremoniously turned adrift by the parents to shift for themselves. If possible, they locate farther up the stream, but, if this is impracticable, select the nearest situation possessing the necessary requirements. It sometimes happens that there are so many dams on the same stream that the back-water from one sets into the next, and that in turn into the one preceding, and so on through the series. It is usually the case that a large colony in any one locality is derived from a single pair of beavers.

Occasionally solitary or "lone beavers" are met with by trappers; animals that do not erect dams or houses, but reside in holes and clefts in the banks which they have excavated, or which are the product of nature or of some of the burrowing tribes, as the otter. The cause of their abandoning the society of their kind is unknown. It may be an excess of that melancholic temperament that is assigned to the species; possibly, the hermit is the sole representative of an extirpated colony; perhaps a bachelor unfortunate in being unable to procure a helpmate; the Indian tribes represent them as pariahs or outcasts, doomed by their kind to solitude on account of shiftlessness or idleness. Certain it is, they are seldom in good condition, and their very mode of living precludes industry.

The trapping of beaver may be considered as an art in itself, as it demands no small expenditure of patience and perseverance to acquire the experience necessary to make it a lucrative calling. Once on the ground selected as the scene of his labors, the trapper follows the creeks and streams, keeping a sharp lookout for "sign." Every prostrate tree is examined to see if it be the work of the beaver; tracks are sought for in the mud and sand; and trails through grass and ferns submitted to careful inspection. The lay of the land having been thoroughly studied, and the presence, movements, haunts, and habits of the animal determined, traps are set at frequent intervals in those localities most likely to produce satisfactory results, and duly baited with "medicine." They are placed both on land and in the water; in the runways, at the landing-places, about the dwellings, and before the store-houses, and are visited daily. On land the old-fashioned "dead-fall" has the preference, as it breaks the animal's back without damaging the skin, while the steel trap in such locality only too frequently results in the escape of the quarry, though at the expense of some one of its members; for the beaver does not hesitate to exercise its sharp teeth in the performance of amputation in order to secure safety. That judgment is demanded in preparing a dead-fall is evident from the fact that it must be adjusted with such nicety that no animal larger than a beaver can pass beneath it, and yet be incapable of being disengaged by anything smaller, such as a mink or musk-rat; the drop-log, too, must be of dried peeled wood, lest it be pulled down by the very animals it is intended to capture, and carried off to their store-house. The "medicine" used as bait, sometimes denominated "bark-stone," is the product of a gland of the beaver, of peculiar, disagreeable odor and bitter taste, known in medicine as *castoreum*, which has earned for itself considerable reputation as an antispasmodic and nervine, though of late years it has largely been superseded by remedies of more agreeable flavor; for some reason it proves very attractive to beaver, alluring alike both old and young of both sexes. A bit of peeled apple, or the bulb of the water-lily, is also used as "medicine," but is not considered as "taking."

Where the water is constantly ebbing and flowing, steel traps are frequently of little value, though under ordinary circumstances to be preferred. A trap requires some six inches of water over it, with still deeper water beyond, for the moment the beaver feels its jaws, which invariably grasp a foot or toe, he turns a somersault into the deeper pool in the vain hope to shake it off, and there drowns. But, should the water be deeper, he swims over the trap unharmed; if lower, he releases himself by amputation; and a beaver who once tastes the perils of a trap is not only ever careful of assuming a second risk of the kind, but seems to possess the faculty of warning his companions. When a trap is set before the dwelling, the channel leading to the door is found by sounding, and it is placed therein, guarded on each side by two stakes that preclude passing except by the dangerous path. It is placed a little nearer one stake, in order that any attempt to cut it will insure a fore-foot touching the pan; if the other stake is attacked, then a hind-foot is caught.

Sometimes, especially in winter, stakes are driven through the ice so as effectually to block up the entrance to the house, whose roof is then broken open, and the inmates dispatched. Again, the dam is cut in numerous places and traps are set in the openings, that the beaver may be caught while attempting to repair the breaches. But neither of these processes is in vogue with the true trapper, unless the colony be a very small one, as the animals are likely to have burrows in the banks that serve as store-houses into which they retire at the first alarm; and the loss of two or three of their number while repairing the dam will render the survivors extremely cautious and wary, perhaps cause them to migrate in a body.

The quickness with which a colony discovers a wholesale attempt against their peace is astonishing; yet if their numbers are undisturbed, or diminished but gradually, even the presence of civilization will not drive them from their haunts. To-day beaver are returning to streams in Michigan, long ago abandoned by their race, simply because they find themselves unmolested, the demand for beaver-peltry being slight, and the prices paid out of all proportion to the labor entailed in trapping. It has been said that, if a dam or house be once injured by the hand of man, the colony at once disappears. But that this is fallacious is proved by the following: Twenty-two miles from Marquette, Michigan, on the Carp River, a beaver colony began the erection of a new dam. Though the embankment of a railway ran nearly parallel with the stream, and trains passed backward and forward daily, they seemed in no way disturbed, and worked steadily on until the water had risen a foot or more. The track-master, observing that this endangered the line—for the embankment had been utilized as a wing of the dam—ordered the water drawn off. But the following day the beavers had repaired the damage done them, and the water was at its former height. Again and again and again was the dam cut through, and as often would it be repaired. All in all, it was cut and repaired some fifteen or twenty times ere the beavers were sufficiently discouraged to abandon their attempts.

THE PROGRESS OF THE WORKING-CLASSES IN THE LAST HALF-CENTURY.*

By ROBERT GIFFEN, LL. D.,
PRESIDENT OF THE STATISTICAL SOCIETY.

WE are carried back on this occasion very naturally to the origin of the society, by an impending event which now casts its shadow before—our approaching jubilee, which we may hope will be worthily celebrated. On such an occasion, I believe the subject on which I propose to address you to-night will be not unsuitable—a review of the official statistics bearing on the progress of the working-classes—the masses of the nation—in the last half-century. If you go back to the early records of the society, you will find that one of the leading objects of its founders was to obtain means by which to study the very question I have selected. Happily we have still with us one or two honored members associated with the early history of the society—I may mention Dr. Guy and Sir Rawson Rawson—who will bear me out in what I have stated. I may remind you, moreover, that one of the founders of the society was Mr. Porter, of the Board of Trade, whose special study for years was much the same, as his well-known book, "The Progress of the Nation," bears witness; and that in one of the earliest publications of the society, a volume preceding the regular issue of the "Journal," he has left a most interesting account of what he hoped might be effected by means of statistics in studying the subject I have put before you, or the more general subject of the "Progress of the Nation." In asking you, therefore, to look for a little at what statistics tell us of the progress of the great masses of the nation, I feel that I am selecting a subject which is con-

* Inaugural address before the London Statistical Society, read November 20, 1883. Mr. Gladstone writes to Mr. Giffen December 28, 1883: "I have read with great pleasure your masterly paper. It is probably, in form and in substance, the best reply to George."

nected with the special history of the society. That it happens for the moment to be attracting a considerable amount of popular attention in connection with sensational politics and sociology, with agitations for land nationalization and collectivism among pretended representatives of the working-classes, is an additional reason for our not neglecting this question ; but it is a question to which the society has a primary claim, and which the authors of the agitations I have referred to would have done well to study from the statistical point of view.

There are two or three ways in which statistics may throw light on such a question as I have put forward. The first and most direct is to see what records there are of the money earnings of the masses now and fifty years ago, ascertain whether they have increased or diminished, and then compare them with the rise or fall in the prices of the chief articles which the masses consume. Even such records would not give a complete answer. It is conceivable, for instance, that, while earning more money, and being able to spend it to more advantage, the working-classes might be no better off than formerly. There may be masses, as there are individuals, who do not know how to spend. The question of means, however, will carry us some distance on the road to our object. We shall know that the masses must be better off, unless they have deteriorated in the art of spending, a subject of separate inquiry.

In investigating such records, however, we have to recognize that the ideal mode of answering the question is not yet possible. That mode would be to draw up an account of the aggregate annual earnings of the working-classes for a period about fifty years ago, and a similar account of the aggregate annual earnings of the same classes at the present time, and then compare the average per head and per family at the different dates. Having thus ascertained the increase or diminution in the amount per head at the different dates, it would be comparatively easy, though not in itself quite so easy a matter as it seems, to ascertain how much less or how much more the increased or diminished sum would buy of the chief articles of the workman's consumption. But no such account that I know of has been drawn up, except for a date about fifteen or sixteen years ago, when Mr. Dudley Baxter and Professor Leone Levi both drew up statements of enormous value as to aggregate earnings, statements which it would now be most desirable to compare with similar statements for the present time, if we could have them, and which will be simply invaluable to future generations. In the absence of such statements, all that can be done is to compare what appear to be the average wages of large groups of the working-classes. If it is found that the changes in the money wages of such groups are in the same direction, or almost all in the same direction, then there would be sufficient reason for believing that similar changes had occurred throughout the entire mass. It would be in the highest degree improbable that precisely those changes which could not be traced were in the opposite direction. The difficulty in the way is that, in a period of fifty years in a country like England, the character of the work itself changes. The people who have the same names at different times are not necessarily doing the same work. Some forms of work pass wholly away, and wholly new forms come into existence. Making all allowances, however, and selecting the best comparative cases possible, some useful conclusion seems obtainable.

What I propose to do first and mainly, as regards this point, is to make use of an independent official record which we have to thank Mr. Porter for commencing. I mean the record of wages, which has been maintained for many years in the "Miscellaneous Statistics of the United Kingdom," and which was previously commenced and carried on in the volumes of "Revenue and Population Tables" which Mr. Porter introduced at the Board of Trade about fifty years ago. It is curious on looking back through these volumes to find how difficult it is to get a continuous record. The wages in one volume are for certain districts and trades; in a subsequent volume, for different districts and trades; the descriptive classifications of the workers are also constantly changing. Picking my way through the figures, however, I have to submit the following particulars of changes in money wages between a period forty to fifty years ago—it is not possible to get the same year in all cases to start from—and a period about two years ago, which may be taken as the present time. This comparison leaves out of account the length of hours of work, which is a material point I shall notice presently.

Comparison of Wages Fifty Years ago and at Present Time.

[From "Miscellaneous Statistics of the United Kingdom," and Porter's "Progress of the Nation."]

OCCUPATION.	Place.	Wages fifty years ago, per week.	Wages present time, per week.	Increase or decrease, amount per cent.	
		s. d.	*s. d.*	*s. d.*	
Carpenters	Manchester	24 00	34 00	10 00 (+)	42
"	Glasgow	14 00	26 00	12 00 (+)	85
Bricklayers	Manchester *	24 00	36 00	12 00 (+)	50
"	Glasgow	15 00	27 00	12 00 (+)	80
Masons	Manchester *	24 00	29 10	5 10 (+)	24
"	Glasgow	14 00	23 8	9 8 (+)	69
Miners	Staffordshire	2 8†	4 00†	1 4 (+)	50
Pattern-weavers	Huddersfield	16 00	25 00	9 00 (+)	55
Wool-scourers	"	17 00	22 00	5 00 (+)	30
Mule-spinners	"	25 6	30 00	4 6 (+)	20
Weavers	"	12 00	26 00	14 00 (+)	115
Warpers and beamers	"	17 00	27 00	10 00 (+)	58
Winders and reelers	"	6 00	11 00	5 00 (+)	83
Weavers (men)	Bradford	8 3	20 6	12 3 (+)	150
Reeling and warping	"	7 9	15 6	7 9 (+)	100
Spinning (children)	"	4 5	11 6	7 1 (+)	160

* 1825. † Wages per day.

Thus, in all cases where I have found it possible from the apparent similarity of the work to make a comparison, there is an enormous apparent rise in money wages, ranging from 20, and in most cases from 50 to 100 per cent, and in one or two instances more than 100 per cent.* This understates, I believe, the real extent of the change. Thus, builders' wages are given at the earlier date as so much weekly, whereas in the later returns a distinction is made between summer and winter wages, the hours of labor being less in winter, and as the wages are so much per hour, the week's wages being also less, so that it has been possible to strike a mean for the later period, while it does not appear that anything more is meant at the early period than the usual weekly wage, which would be the summer wage. Without making this point, however, it is obvious that in all cases there is a very great rise.

Before passing from this point, there is another and continuous official record I would refer to. Unfortunately, it does not go back for much more than thirty years. Still, as far as it goes, the evidence is in the same direction. I refer to the return of merchant-seamen's wages annually issued by the Board of Trade, in what is known as the "Progress of Merchant Shipping Return." From this return may be derived the following comparison of seamen's wages:

Comparison of Seamen's Money Wages per Month at 1850 and the Present Time.

[From the "Progress of Merchant Shipping Return."]

	1850, sailing.		Present time, steam.		Increase.		
					Amount.		Per cent.
	s.	d.	s.	d.	s.	d.	
Bristol	45	00	75	00	30	00	66
Glasgow	45	00	70	00	25	00	55
Liverpool (1)	50	00	67	6	16	6	33
" (2)	50	00	85	00	35	00	70
" (3)	45	00	60	00	15	00	33
" (4)	40	00	50	00	10	00	25
" (5)	42	6	60	00	17	6	40
London (1)	45	00	75	00	30	00	66
" (2)	50	00	77	6	27	6	55
" (3)	45	00	65	00	20	00	45
" (4)	45	00	70	00	25	00	55
" (5)	40	00	67	6	27	6	69
" (6)	40	00	67	6	27	6	69

Here, again, there is an enormous rise in money wages. This return is specially subject to the observation that money wages are only part of the wages of seamen, but I assume it is not open to dispute that, with the improvement in our shipping, there has been an improvement in the food and lodging of the sailor, quite equal to the improvement in his money wage.

This question of seamen's wages, however, well illustrates the difficulty of the whole subject. Ships are not now navigated by able sea-

* The mean of the percentages of increase is over 70.

men so much as by engineers and stokers. It would seem that, as a class, the new men all round are paid better than the able seamen, but I should not press this point; it might well be the case that steamships as a whole could be worked by an inferior class of laborers as compared with sailing-ships, and yet the fact that inferior labor is sufficient for this special trade would be quite consistent with the fact that the whole conditions of modern labor require more skill than the conditions fifty years ago, so that there is more labor relatively at the higher rates than used to be the case.

The comparison, except for seamen's wages, where it has only been possible to go back for about thirty years, is made between a period about fifty years ago and the present time only. It would have complicated the figures too much to introduce intermediate dates. I may state, however, that I have not been inattentive to this point, and that, if we had commenced about twenty to twenty-five years ago, we should also have been able to show a very great improvement since that time, while at that date also, as compared with an earlier period, a great improvement would have been apparent. A careful and exhaustive investigation of the records of wages I have referred to, in comparison with the numbers employed in different occupations, as shown by the census reports, would in fact repay the student who has time to make it; and I trust the investigation will yet be made.

The records do not include anything relating to the agricultural laborer, but from independent sources—I would refer especially to the reports of the recent Royal Agricultural Commission—we may perceive how universal the rise in the wages of agricultural laborers has been, and how universal at any rate is the complaint that more money is paid for less work. Sir James Caird, in his "Landed Interest" (page 65), puts the rise at 60 per cent as compared with the period just before the repeal of the corn-laws, and there is much other evidence to the same effect. The rise in the remuneration of labor in Ireland in the last forty years is also one of the facts which has been conspicuously brought before the public of late. In no other way is it possible to account for the stationariness of rents in Ireland for a long period, notwithstanding the great rise in the prices of the cattle and dairy products which Ireland produces, and which, it has been contended, would have justified a rise of rents. The farmer and the laborer together have in fact had all the benefit of the rise in agricultural prices.

The next point to which attention must be drawn is the shortening of the hours of labor which has taken place. While the money wages have increased as we have seen, the hours of labor have diminished. It is difficult to estimate what the extent of this diminution has been, but, collecting one or two scattered notices, I should be inclined to say very nearly 20 per cent. There has been at least this reduction in the textile, engineering, and house-building trades. The workman gets from 50 to 100 per cent more money for 20 per cent less work; in round figures, he has gained from 70 to 120 per cent in fifty years in money return. It is just possible of course that the workman may do as much or nearly as much in the shorter period as he did in his longer hours. Still, there is the positive gain in his being less time at his task, which many of the classes still tugging lengthily day by day at the oar would appreciate. The workman may have been wise or unwise in setting much store by shorter hours in bettering himself, but the shortening of the hours of labor is undoubtedly to be counted to the good as well as the larger money return he obtains.

We come then to the question of what the changes have been in the prices of the chief articles of the workman's consumption. It is important, to begin with, that, as regards prices of commodities generally, there seems to be little doubt things are much the same as they were forty or fifty years ago. This is the general effect of the inquiries which have been made first as to the depreciation of gold consequent on the Australian and Californian gold discoveries, and next as to the appreciation of gold which has taken place within the last twenty years consequent on the new demands for gold which have arisen, and the falling off in the supply as compared with the period between 1850 and 1860. It would burden us too much to go into these inquiries on an occasion like the present, and therefore I only take the broad result. This is that, while there was a moderate rise of prices all round between the years 1847–'50, just before the new gold came on the market, and the year 1862, when Mr. Jevons published his celebrated essay, a rise not exceeding about 20 per cent, yet within the last twenty years this rise has disappeared, and prices are back to the level, or nearly to the level, of 1847–'50. The conclusion is that, taking things in the mass, the sovereign goes as far as it did forty or fifty years ago, while there are many new things in existence at a low price which could not then have been bought at all. If in the interval the average money earnings of the working-classes have risen between 50 and 100 per cent, there must have been an enormous change for the better in the means of the working-man, unless by some wonderful accident it has happened that his special articles have changed in a different way from the general run of prices.

But looking to special articles, we find that on balance prices are lower and not higher. Take wheat. It is notorious that wheat, the staff of life, has been lower on the average of late years than it was before the free-trade era. Even our fair-trade friends, who find it so difficult to see very plain things, were forced to allow, in that wonderful manifesto which was published in the "Times" some weeks back, that wheat is about 5*s.* a quarter cheaper on the average than it was. The facts, however, deserve still more careful statement to enable us to realize the state of things fifty years ago and at the present time.

The fair-trade statement, if I remember rightly, showed an average fall of 5*s.* in the price of wheat, comparing the whole period since the repeal of the corn-laws with a long period before. This may have been right or wrong for the purpose in hand, but for our present purpose, which is to compare the present period with that of half a century ago, it is important to note that it is mainly within the last ten years the steadily low price of wheat has been established. Comparing the ten years before 1846 with the last ten years, what we find is that, while the average price of wheat in 1837–'46 was 58*s.* 7*d.*, it was 48*s.* 9*d.* only in the last ten years—a reduction not of 5*s.* merely, but 10*s.* The truth is, the repeal of the corn-laws was not followed by an *immediate* decline of wheat on the average. The failure of the potato-crop, the Crimean War, and the depreciation of gold, all contributed to maintain the price, notwithstanding free trade, down to 1862. Since then steadily lower prices have ruled; and when we compare the present time with half a century ago, or any earlier part of the century, these facts should be remembered.

There is a still more important consideration. Averages are very good for certain purposes, but we all know in this place that a good deal sometimes turns upon the composition of the average—upon whether it is made up of great extremes, or whether the individual elements depart very little from the average. This is specially an important matter in a question of the price of food. The average of a necessary of life over a long period of years may be moderate, but if in some years the actual price is double what it is in other years, the fact of the average will in no way save from starvation at certain periods the workman who may have a difficulty in making both ends meet in the best of times. What we find, then, is that, fifty years ago, the extremes were disastrous compared with what they are at the present time. In 1836 we find wheat touching 36*s.*; in 1838, 1839, 1840, and 1841, we find it touching 78*s.* 4*d.*, 81*s.* 6*d.*, 72*s.* 10*d.*, and 76*s.* 1*d.*; in all cases double the price of the lowest year, and nearly double the "average" of the decade; and in 1847 the price of 102*s.* 5*d.*, or three times the price of the lowest period, is touched. If we go back earlier we find still more startling extremes. We have such figures as 106*s.* 5*d.* in 1810; 126*s.* 6*d.* in 1812; 109*s.* 9*d.* in 1813, and 96*s.* 11*d.* in 1817; these figures being not merely the extremes touched, but the actual averages for the whole year. No doubt in the early part of the century the over-issue of inconvertible paper accounts for part of the nominal prices, but it accounts for a very small part. What we have to consider, then, is, that fifty years ago the working-man with wages, on the average, about half, or not much more than half, what they are now, had at times to contend with a fluctuation in the price of bread which implied sheer starvation. Periodic starvation was, in fact, the condition of the masses of working-men throughout the kingdom fifty years ago, and the references to the subject in the economic literature of the time are most instructive. M. Quetelet, in his well-known great book, points to the obvious connection between the high price of bread following the bad harvest of 1816 and the excessive rate of mortality which followed. To this day you will find tables in the registrar-general's returns which descend from a time when a distinct connection between these high prices of bread and excessive rates of mortality was traced. But within the last twenty years what do we find? Wheat has not been, on the average, for a whole year so high as 70*s.*, the highest averages for any year being 64*s.* 5*d.* in 1867, and 63*s.* 9*d.* in 1868; while the highest average of the last ten years alone is 58*s.* 8*d.* in 1873; that is only about 10*s.* above the average of the whole period. In the twenty years, moreover, the highest price touched at any period was just over 70*s.*, viz., 70*s.* 5*d.* in 1867, and 74*s.* 7*d.* in 1868; while in the last ten years the figure of 70*s.* was not even touched, the nearest approach to it being 68*s.* 9*d.* in 1877. Thus of late years there has been a steadily low price, which must have been an immense boon to the masses, and especially to the poorest. The rise of money wages has been such, I believe, that working-men, for the most part, could have contended with extreme fluctuations in the price of bread better than they did fifty years ago. But they have not had the fluctuations to contend with.

It would be useless to go through other articles with the same detail. Wheat had quite a special importance fifty years ago, and the fact that it no longer has the same importance—that we have ceased to think of it as people did fifty years ago—is itself significant. Still, taking one or two other articles, we find on the whole a decline:

Prices of Various Articles about Fifty Years ago and at Present Time.

		1839–'40.		Present time.	
		s.	*d.*	*s.*	*d.*
Sugar	per cwt.	68	8*	21	9†
Cotton cloth exported	per yard	00	5⅝	00	3¼
		(1840)		(1882)	
Inferior beasts	per 8 pounds	3	1	4	3¾
Second class	"	3	6	4	9¾
Third "	"	3	11¾	5	7½
Inferior sheep	"	3	5	5	7
Second class	"	3	10¼	6	1¼
Large hogs	"	4	3½	4	6

I should have liked a longer list of articles, but the difficulty of comparison is very serious. It may be stated broadly, however, that while sugar and such articles have declined largely in price, and while

* Porter's "Progress of the Nation," p. 543. In the paper as read to the society, I gave the price without the duty, but including the duty the price was what is now given here. The average price, with the duty of the ten years ending 1840, was 58*s.* 4*d.*

† Average price of raw sugar imported.

clothing is also cheaper, the only article interesting the workman much which has increased in price is meat, the increase here being considerable. The "only," it may be supposed, covers a great deal. The truth is, however, that meat fifty years ago was not an article of the workman's diet as it has since become. He had little more concern with its price than with the price of diamonds. The kind of meat which was mainly accessible to the workman fifty years ago, viz., bacon, has not, it will be seen, increased sensibly in price.

Only one question remains. Various commodities, it may be admitted, have fallen in price, but house-rent, it is said, has gone up. We have heard a good deal lately of the high prices of rooms in the slums. When we take things in the mass, however, we find that, however much some workmen may suffer, house-rent in the aggregate can not have gone up in a way to neutralize, to any serious extent, the great rise in the money wages of the workman. It appears that, in 1834, when the house duty, which had existed up to that date, was abolished, the annual value of dwelling-houses charged to duty was £12,603,000, the duty being levied on all houses above £10 rental in Great Britain. In 1881–'82 the annual value of dwelling-houses charged to duty, the duty being levied on houses above £20 only, was £39,845,000, while the value of the houses between £10 and £20 was £17,040,000, making a total of £56,885,000, or between four and five times the total of fifty years ago. Population, however, in Great Britain has increased from about 16,500,000 in 1831 to nearly 30,000,000 in 1881, or nearly 100 per cent. Allowing for this, the increase in value would be about £32,000,000 on a total of about £25,000,000, which may be considered the increased rent which householders above £10 have to pay—the increase being about 130 per cent. Assuming that houses under £10 have increased in proportion, it may be considered that house-rents are now one and a half times more than they were fifty years ago. In other words, a workman who paid £3 a year fifty years ago, would now pay £7 10*s*. Even, however, if rent were a fourth part of the workman's earnings fifty years ago, he would still be much better off at the present time than he was. His whole wages have doubled, while the prices of no part of his necessary consumption, except rent, as we have seen, have increased—on the contrary, they have rather diminished. Say, then, that the rent, which was a fourth part of his expenditure, has increased one and a half times, while his whole wage has doubled, the account, on a wage of 20*s*. fifty years ago, and 40*s*. now, would stand—

	Fifty years ago.		Present time.	
	s.	*d.*	*s.*	*d.*
Wage	20	00	40	00
Deduct for rent	5	00	12	6
Balance for other purposes	15	00	27	6

—showing still an enormous improvement in the workman's condition.

It may be pointed out, however, that houses are undoubtedly of better value all round than they were fifty years ago. More rent is paid because more capital is in the houses, and they are better houses. It appears, also, that fifty years ago there were far more exemptions than there are now, rural dwellings particularly being favored as regards exemption. The increase of rent for the same accommodation, there is consequently reason to believe, has not been nearly so great as these figures would appear to show. It has further to be considered that the whole annual value of the dwelling-houses under £10 even now is £17,885,000 only, the number of houses being 3,124,000. This must be a very small proportion of the aggregate earnings of those portions of the working-classes who live in houses under £10 rent, and even adding to it the value of all the houses up to £20, which would bring up the total to £34,925,000, the proportion would still be very small. On the 5,000,000 families at least of the working-classes in Great Britain, the sum would come to about £7 per family, which is not the main portion of an average working-man's expenditure.*

We return, then, to the conclusion that the increase of the money wages of the working-man in the last fifty years corresponds to a real gain. While his wages have advanced, most articles he consumes have rather diminished in price, the change in wheat being especially remarkable, and significant of a complete revolution in the condition of the masses. The increased price in the case of one or two articles—particularly meat and house-rent—is insufficient to neutralize the general advantages which the workman has gained. Meat formerly was a very small part of his consumption, and allowing to house-rent a much larger share of his expenditure than it actually bore, the increase in amount would still leave the workman out of his increased wage a larger margin than he had before for miscellaneous expenditure. There is reason to believe, also, that the houses are better, and that the increased house-rent is merely the higher price for a superior article which the workman can afford.

It has to be added to all this, that, while the cost of government has been greatly diminished to the working-man, he gets more from the government expenditure than he formerly did. It would not do to count things twice over, and as the benefit to the working-man of diminished taxes has already been allowed for in the lower prices of

* It may be convenient to note here that the figures as to dwelling-houses which I have made use of are those relating to the inhabited house duty. The figures as to houses in the income-tax returns include shops and factories as well as dwelling-houses, and are not available in a question of house-rent. I have also omitted the question of rates. The rates per pound, however, have not increased as compared with what they were formerly, and it would make no material difference if they were to be included. The workman's payment for rates and rent together can not have increased more than is here stated for rent.

wheat and sugar, we need say nothing more on this head. But few people seem to be aware how, simultaneously with this reduction of the cost of government, there has been an increase of the expenditure of the government for miscellaneous civil purposes, of all of which the workman gets the benefit. It may be stated broadly that nearly £15,000,000 of the expenditure of the central government for education, for the post-office, for inspection of factories, and for the miscellaneous purposes of civil government, is entirely new as compared with fifty years ago. So far as the expenditure is beneficial, the masses get something they did not get before at all. It is the same, even more markedly, with local government. In Great Britain, the annual outlay is now about £60,000,000, as compared with £20,000,000 fifty years ago. This £20,000,000 was mainly for poor-relief and other old burdens. Now the poor-relief and other old burdens are much the same, but the total is swollen by a vast expenditure for sanitary, educational, and similar purposes, of all of which the masses of the population get the benefit. To a great deal of this expenditure we may attach the highest value. It does not give bread or clothing to the working-man, but it all helps to make life sweeter and better, and to open out careers even to the poorest. The value of the free library, for instance, in a large city, is simply incalculable. All this outlay the workman has now the benefit of, as he had not fifty years ago. To repeat the words I have already used, he pays less taxes, and he gets more—much more—from the government.*

* With regard to this question of prices, I have been favored since the delivery of this address with the copy of a letter, dated June 11, 1881, addressed by Mr. Charles Hawkins, of 27 Savile Row, to the editor of the "Daily News," on the cost *per patient* of the expenditure of St. George's Hospital in 1830 and 1880. The facts stated confirm in an interesting way what is here said as to the cost of articles of the workman's consumption fifty years ago and at the present time. Mr. Hawkins, who was at one time one of the treasurers of the hospital, and therefore speaks with authority, gives the following table and notes:

"Although each patient costs now 1*s.* 1*d.* less than in 1830, there have been great alterations in the different items of expenditure, viz.:

	Cost per Patient.			
	1830.		1880.	
	s.	*d.*	*s.*	*d.*
Meat	18	4	22	2
Bread and flour	10	7	4	1
Wine and spirits	00	10	3	3
Malt liquor	5	5	2	6
Milk	6	2	5	11
Tea and grocery	3	10	3	5
Drugs	16	5	7	11
Coals and wood	10	6	3	10
Laundry	2	10	4	10
Instruments and surgical appliances	1	9	5	2
Staff—officers, servants, nurses	20	3	34	3

"Had wheat cost in 1880 what it did in 1830, £1,884 must have been spent in bread and flour instead of £738. The cost of port wine in 1830 was £72 per pipe; in 1880, As already anticipated, however, the conclusion thus arrived at only carries us part of the way. Assuming it to have been shown that the masses have more money than they had fifty years ago, and that the prices of the chief articles they consume are cheaper rather than dearer, the question remains whether the condition of the masses has in fact been improved. This can only be shown indirectly by statistics of different kinds, which justify conclusions as to the condition of the people to whom they apply. To such statistics I propose now to draw your attention for a moment. I need hardly say that any evidence they contain as to the condition of the people having actually improved corroborates what has been already said as to their having had the means of improvement in their hands. The evidence is cumulative, a point of material importance in all such inquiries.

The first and the most important statistics on this head are those relating to the length of life among the masses of the nation. Do the people live longer than they did? Here I need not detain you. A very effective answer was supplied last session by Mr. Humphreys, in his able paper on "The Recent Decline in the English Death-Rate."* Mr. Humphreys there showed conclusively that the decline in the death-rate in the last five years, 1876–'80, as compared with the rates on which Dr. Farr's English "Life Table" was based—rates obtained in the years 1838–'54—amounted to from 28 to 32 per cent in males at each quinquenniad of the twenty years from five to twenty-five, and in females at each quinquenniad from five to thirty-five to between 24 and 35 per cent; and that the effect of this decline in the death-rate is to raise the mean duration of life among males from 39·9 to 41·9 years, a gain of two years in the average duration of life, and among females from 41·9 to 45·3 years, a gain of nearly three and a half years in the average duration of life. Mr. Humphreys also showed that by far the larger proportion of the increased duration of human life in England is lived at useful ages, and not at the dependent ages of either childhood or old age. This little statement is absolutely conclusive on the subject; but we are apt to overlook how much the figures mean. No such change could take place without a great increase in the vitality of the people. Not only have fewer died, but the masses who have lived must have been healthier, and

£45. In 1830 many of the patients provided themselves with tea and sugar. Under the head 'Drugs' is included the cost of leeches; in 1846 14,800 leeches were used, at a cost of £143; in 1880 only 425, costing £1 16*s*. In 1833 another hospital, treating double the number of patients, used 48,900 leeches, but in 1880 only 250.

"These items show the great advantage of the reduction of price in some articles of diet, and the great extra expenditure now necessary for the treatment of hospital patients, depending on the greater call for additional 'staff,' more especially for nursing, and an altered mode of treatment of accidents and operations, as also the greater amount of stimulants now exhibited, etc."

* See Statistical Society's "Journal," vol. xlvi, p. 195, etc.

have suffered less from sickness than they did. Though no statistics are available on this point, we must assume that like causes produce like effects; and if the weaker, who would otherwise have died, have been able to survive, the strong must also have been better than they would otherwise have been. From the nature of the figures, also, the improvement must have been among the masses, and not among a select class whose figures throw up the average. The figures to be affected relate to such large masses of population, that so great a change in the average could not have occurred if only a small percentage of the population had improved in health.

I should like, also, to point out that the improvement in health actually recorded obviously relates to a transition stage. Many of the improvements in the condition of the working-classes have only taken place quite recently. They have not, therefore, affected all through their existence any but the youngest lives. When the improvements have been in existence for a longer period, so that the lives of all who are living must have been affected from birth by the changed conditions, we may infer that even a greater gain in the mean duration of life will be shown. As it is, the gain is enormous. Whether it is due to better and more abundant food and clothing, to better sanitation, to better knowledge of medicine, or to these and other causes combined, the improvement has beyond all question taken place.

The next figures I shall refer to are those well-known ones relating to the consumption of the articles which the masses consume. I copy merely the figures in the "Statistical Abstract" for the years 1840 and 1881:

Quantities of the Principal Imported and Excisable Articles retained for Home Consumption, per Head of the Total Population of the United Kingdom.

		1840.	1881.
Bacon and hams	pounds	0·01	13·93
Butter	"	1·05	6·36
Cheese	"	0·92	5·77
Currants and raisins	"	1·45	4·34
Eggs	No.	3·63	21·65
Potatoes	pounds	0·01	12·85
Rice	"	0·90	16·32
Cocoa	"	0·08	0·31
Coffee	"	1·08	0·89
Corn, wheat, and wheat-flour	"	42·47	216·92
Raw sugar	"	15·20	58·92
Refined sugar	"	nil	8·44
Tea	"	1·22	4·58
Tobacco	"	0·86	1·41
Wine	gallons	0·25	0·45
Spirits	"	0·97	1·08
Malt	bushels	1·59	1·91*

* Year 1878.

This wonderful table may speak for itself. It is an obvious criticism that many of the articles are also articles of home production, so that the increase does not show the real increase of the consumption of the whole population per head. Assuming a stationary production at home, the increased consumption per head can not be so much as is here stated for the imported article only. There are other articles, however, such as rice, tea, sugar, coffee, tobacco, spirits, wine, and malt, which are either wholly imported, or where we have the excisable figures as well, and they all—with the one exception of coffee—tell a clear tale. The increase in tea and sugar appears especially significant, the consumption per head now being four times in round figures what it was forty years ago. There could be no better evidence of diffused material well-being among the masses. The articles are not such that the increased consumption by the rich could have made much difference. It is the consumption emphatically of the mass which is here in question.

As regards the articles imported, which are also articles of home production, it has, moreover, to be noted that in several of them, bacon and hams, cheese and butter, the increase is practically from nothing to a very respectable figure. The import of bacon and hams alone is itself nearly equal to the estimated consumption among the working-classes fifty years ago, who consumed no other meat.

The only other figures I shall mention are those relating to education, pauperism, crime, and savings-banks. But I need not detain you here. The figures are so well known that I must almost apologize for repeating them. I only insert them to round off the statement.

As to education, we have practically only figures going back thirty years. In 1851, in England, the children in average attendance at schools aided by parliamentary grants numbered 239,000, and in Scotland 32,000; in 1881 the figures were 2,863,000 and 410,000. If anything is to be allowed at all in favor of parliamentary grants as raising the character of education, such a change of numbers is most significant. The children of the masses are, in fact, now obtaining a good education all round, while fifty years ago the masses had either no education at all or a comparatively poor one. Dropping statistics for the moment, I should like to give my own testimony to an observed fact of social life—that there is nothing so striking or so satisfactory to those who can carry their memories back nearly forty years, as to observe the superiority of the education of the masses at the present time to what it was then. I suppose the most advanced common education forty or fifty years ago was in Scotland, but the superiority of the common-school system there at the present day to what it was forty years ago is immense. If Scotland has gained so much, what must it have been in England where there was no national system fifty years ago at all? Thus at the present day not only do we get all children into schools, or nearly all, but the education for the increased numbers is better than that which the fortunate few alone obtained before.

Next as to crime: the facts to note are that rather more than forty years ago, with a population little more than half what it is now, the number of criminal offenders committed for trial (1839) was 54,000; in England alone, 24,000. Now the corresponding figures are, United Kingdom, 22,000, and England, 15,000; fewer criminals by a great deal in a much larger population. Of course the figures are open to the observation that changes in legislation providing for the summary trial of offenses that formerly went to the assizes may have had some effect. But the figures show so great and gradual a change that there is ample margin for the results of legislative changes, without altering the inference that there is less serious crime now in the population than there was fifty years ago. Thus an improvement as regards crime corresponds to the better education and well-being of the masses.

Next as regards pauperism: here, again, the figures are so imperfect that we can not go back quite fifty years. It is matter of history, however, that pauperism was nearly breaking down the country half a century ago. The expenditure on poor-relief early in the century and down to 1830'–31 was nearly as great at times as it is now. With half the population in the country that there now is, the burden of the poor was the same. Since 1849, however, we have continuous figures, and from these we know that, with a constantly increasing population, there is an absolute decline in the amount of pauperism. The earliest and latest figures are:

Paupers in Receipt of Relief in the under-mentioned Years at given Dates.

	1849.	1881.
England	934,000	803,000
Scotland	122,000*	102,000
Ireland	620,000	109,000
United Kingdom	1,676,000	1,014,000

Thus in each of the three divisions of the United Kingdom there is a material decline, and most of all in Ireland, the magnitude of the decline there being no doubt due to the fact that the figures are for a period just after the great famine. But how remote we seem to be from those days of famine!

Last of all we come to the figures of savings-banks. A fifty years' comparison gives the following results for the whole kingdom:

	1831.	1881.
Number of depositors	429,000	4,140,000
Amount of deposits	£13,719,000	£80,334,000
" per depositor	£32	£19

* 1859.

An increase of tenfold in the number of depositors, and of fivefold and more in the amount of deposits! It seems obvious from these figures that the habit and means of saving have become widely diffused in these fifty years. The change is, of course, in part due to a mere change in the facilities offered for obtaining deposits; but allowing ample margin for the effect of increased facilities, we have still before us evidence of more saving among the masses.

There is yet one other set of statistics I should like to notice in this connection, those relating to the progress of industrial and provident co-operative societies in England and Wales. These I extract from the special appendix to the "Co-operative Wholesale Society's Annual Almanac and Diary" for the present year (pages 81 and 82). Unfortunately, the figures only go back to 1862, but the growth up to 1862 appears to have been very small. Now, however, most material advance is shown:

	1862.	1881.
Number of members	90,000	525,000
Capital—Share	£428,000	£5,881,000
Loan	55,000	1,267,000
Sales	2,333,000	20,901,000
Net profit	165,000	1,617,000

Such figures are still small compared with what we should like to see them, but they at least indicate progress among the working-classes, and not retrogression or standing still.

To conclude this part of the evidence, we find undoubtedly that in longer life, in increased consumption of the chief commodities they use, in better education, in greater freedom from crime and pauperism, and in increased savings, the masses of the people are better, immensely better, than they were fifty years ago. This is quite consistent with the fact, which we all lament, that there is a residuum still unimproved, but apparently a smaller residuum, both in proportion to the population and absolutely, than was the case fifty years ago; and with the fact that the improvement, measured even by a low ideal, is far too small. No one can contemplate the condition of the masses of the people without desiring something like a revolution for the better. Still, the fact of progress in the last fifty years—progress which is really enormous when a comparison is made with the former state of things—must be recognized. Discontent with the present must not make us forget that things have been so much worse.

But the question is raised, Have the working-classes gained in proportion with others by the development of material wealth during the last fifty years? The question is not one which would naturally excite much interest among those who would answer the primary question as to whether the working-classes have gained or not, as I have done, in the affirmative. Where all are getting on, it does not seem very practical in those who are getting on slowly to grudge the quicker advance of others. Usually those who put the question have some vague idea that the capitalist classes, as they are called, secure for themselves all the benefits of the modern advance in wealth; the rich, it is said, are becoming richer, and the poor are becoming poorer. It will be convenient, then, to examine the additional question specifically. If the answer agrees with what has already been advanced, then, as nobody doubts that material wealth has increased, all will be forced to admit that the working-classes have had a fair share.

At first sight it would appear that the enormous figures of the increase of capital, which belong, it is assumed, to the capitalist classes, are inconsistent with the notion of the non-capitalist classes having had a fair share. In the paper which I read to the Society four years ago, on "The Recent Accumulations of Capital in the United Kingdom," the conclusion at which I arrived was that in the ten years (1865–'75) there had been an increase of 40 per cent in the capital of the nation, and 27 per cent in the amount of capital per head, that is, allowing for the increase of population. Going back to 1843, which is as far as we can go back with the income-tax returns, we also find that since then the gross assessment, allowing for the income from Ireland not then included in the returns, has increased from £280,000,000 to £577,000,000, or more than 100 per cent, in less than fifty years. Assuming capital to have increased in proportion, it is not to be wondered at that the impression of a group of people called the capitalist classes getting richer and richer while the mass remain poor or become poorer should be entertained. Allowing for the increase of population, the growth of capital and income-tax income are really much smaller than the growth of the money income of the working-classes, which we have found to be something like 50 to 100 per cent and more per head in fifty years, but the impression to the contrary undoubtedly exists, and is very natural.

The error is partly in supposing that the capitalist classes remain the same in number. This is not the case; and I have two pieces of statistics to refer to which seem to show that the capitalist classes are far from stationary, and that they receive recruits from period to period—in other words, that wealth, in certain directions, is becoming more diffused, although it may not be diffusing itself as we should wish.

The first evidence I refer to is that of the probate-duty returns. Through the kindness of the Commissioners of Inland Revenue, I am able to put before you a statement of the number of probates granted in 1881, and of the amounts of property "proved," with which we may compare similar figures published by Mr. Porter in his "Progress of the Nation" for 1838. I am sorry to say Mr. Porter's figures for 1838 are far more detailed than those I am able to give; a more minute comparison would be most instructive; but I was unfortunately too late in applying to the Commissioners of Inland Revenue for the details which I found they were most willing to give. However, the statement they supplied to me and the comparison which can thus be made seem most instructive. They are as follow:

Statement of Number of Probates granted in 1882, with Amounts of Property proved, and Average per Probate [from figures supplied by the Commissioners of Inland Revenue]; and Comparison with a Similar Statement for 1838.

[From Porter's "Progress of the Nation," p. 600, *et seq.*]

	Number of probates.		Amount of property.		Amount of property per estate.	
	1882.	1838.	1882.	1838.	1882.	1838.
England	45,555	21,900	£118,120,961	£47,604,755	£2,600	£2,170
Scotland	5,221	1,272	13,695,314	2,817,260	2,600	2,200
Ireland	4,583	2,196	8,544,579	4,465,240	1,900	2,000
United Kingdom	55,359	25,368	£140,360,854	£54,887,255	£2,500	£2,160

Thus, in spite of the enormous increase of property passing at death, amounting to over 150 per cent, which is more than the increase in the income-tax income, the amount of property per estate has not sensibly increased. The increase of the number of estates is more than double, and greater therefore than the increase of population; but the increase of capital per head of the capitalist classes is in England only 19 per cent, and in the United Kingdom only 15 per cent. Curiously enough, I may state, it is hardly correct to speak of the capitalist classes as holding this property, as the figures include a small percentage of insolvent estates; but allowing all the property to belong to the capitalist classes, still we have the fact that those classes are themselves increasing. They may be only a minority of the nation, though I think a considerable minority, as 55,000 estates passing in a year represent from 1,500,000 to 2,000,000 persons as possessing property subject to probate duty; and these figures, it must be remembered, do not include real property at all. Still, small or large as the minority may be, the fact we have before us is that in the last fifty years it has been an increasing minority, and a minority increasing at a greater rate than the increase of general population. Wealth to a certain extent is more diffused than it was.

If I had been able to obtain more details, it would have been possible to specify the different sizes of estates and the different percentages of increase, from which it would not only have appeared whether the owners of personal property were increasing in number, but whether the very rich were adding to their wealth more than the moderately rich, or *vice versa*. But it is something to know at least that there are more owners. I trust the Commissioners of Inland Revenue will see their way in their next report to give more details on this very interesting point.*

Before passing on I should like to add a caution which may not be necessary in this room, but which may be needed outside. All such figures must be taken with a good deal of qualification, owing to variations of detail in the method of levying the duty at different times, variations in the character of the administration, and the like causes. I notice, for instance, an unusually remarkable increase both in the number of owners and amount of property passing in Scotland; this last fact, I believe, having already given rise to the statement that there has been something unexampled in the increase of personal property in Scotland. The explanation appears to be, however, that the increase of property in Scotland is, to some extent, only apparent, being due partly, for instance, to the fact that by Scotch law mortgages are real property, whereas in England they are personal property, so that it was necessary, in the course of administering the tax, to pass a special law enabling the Commissioners of Inland Revenue to bring Scotch mortgages into the category of personal property.† This is only one illustration of the caution with which such figures must be used. Taking them in the lump, and not pressing comparisons between the three divisions of the United Kingdom, or any other points of detail which might be dangerous, we appear to be safe in the main conclusion that the number of owners of personal property liable to probate duty has increased in the last fifty years more than the increase of population, and that on the average these owners are only about 15 per cent richer than they were, while the individual income of the working-classes has increased from 50 to 100 per cent.

The next piece of statistics I have to refer to is the number of separate assessments in that part of Schedule D known as Part I, viz., trades and professions, which excludes public companies and their sources of income, where there is no reason to believe that the number of separate assessments corresponds in any way to the number of individual incomes. Even in Part I there can be no exact correspondence, as partnerships make only one return, but in comparing distant periods it seems not unfair to assume that the increase or decrease of assessments would correspond to the increase or decrease of individual incomes. This must be the case, unless we assume that in the interval material differences were likely to arise from the changes in the num-

* It appears that the increase in the number of probates for less than £1,000 is from 18,490 to 41,278, or about 120 per cent, the average value per probate being much the same; while the increase of the number of probates for more than £1,000 is from 6,878 to 12,629, or over 80 per cent, and the average value per probate has increased from £7,150 to £9,200.

† See "Special Report of Commissioners of Inland Revenue," 1870, vol. i, p. 99. The law on this and other points was altered by 23 and 24 Vict., cap. lxxx.

ber of partnerships to which individuals belonged, or from partnerships as a rule comprising a greater or less number of individuals. Using the figures with all these qualifications, we get the following comparison:

Number of Persons at Different Amounts of Income charged under Schedule D in 1843 and 1879–'80 compared [*in England*].*

	1843.	1879–'80.
£150 and under £200	39,366	130,101
200 " 300	28,370	88,445
300 " 400	13,429	39,896
400 " 500	6,781	16,501
500 " 600	4,780	11,317
600 " 700	2,672	6,894
700 " 800	1,874	4,054
800 " 900	1,442	3,595
900 " 1,000	894	1,396
1,000 " 2,000	4,228	10,352
2,000 " 3,000	1,235	3,131
3,000 " 4,000	526	1,430
4,000 " 5,000	339	758
5,000 " 10,000	493	1,439
10,000 " 50,000	200	785
50,000 and upward	8	68
Total	106,637	320,162

Here the increase in all classes, from the lowest to the highest, is between two and three times, or rather more than three times, with the exception of the highest class of all, where the numbers, however, are quite inconsiderable. Again a proof, I think, of the greater diffusion of wealth so far as the assessment of income to income-tax under Schedule D may be taken as a sign of the person assessed having wealth of some kind, which I fear is not always the case. If the owners of this income, at least of the smaller incomes, are to be considered as not among the capitalists, but among the working-classes—a very arguable proposition—then the increase of the number of incomes from £150 up to say £1,000 a year is a sign of the increased earnings of working-classes, which are not usually thought of by that name. The increase in this instance is out of all proportion to the increase of population.

In giving these figures I have omitted the incomes under £150. There is quite a want of satisfactory data for any comparison, I think, except as regards incomes actually subject to assessment, and the data at the beginning of the period are specially incomplete.

Whichever way we look at the figures, therefore, we have this result, that while the increase of personal property per head of the capitalist class, according to the probate returns, is comparatively small, being only about 15 per cent, yet there is an increase of the number

* The figures for 1843 can not be given for either Scotland or Ireland.

of people receiving good incomes from trades and professions out of all proportion to the increase of population. We can not but infer from this that the number of the moderately rich is increasing, and that there is little foundation for the assertion that the rich are becoming richer. All the facts agree. The working-classes have had large additions to their means; capital has increased in about equal ratio; but the increase of capital per head of the capitalist classes is by no means so great as the increase of working-class incomes.

I should wish further to point out, however, that it is a mistake to speak of the income in the various schedules to the income-tax as the income of a few, or exclusively of classes which can be called capitalist, or rich. A suspicion of this has already been raised by the facts as to trades and professions. Let me just mention this one little fact in addition. Out of £190,000,000 assessed under Schedule A in 1881–'82, the sum of £11,359,000 was exempted from duty as being the income of people whose whole income from all sources was under £150 a year. If we could get at the facts as to how the shares of public companies are held, and as to the immense variety of interests in lands and houses, we should have ample confirmation of what has already appeared from the probate-duty figures, that there is a huge minority interested in property in the United Kingdom, great numbers of whom would not be spoken of as the capitalist classes.

To test the question as to whether there has been any disproportionate increase of capital, and of the income from it, in yet another way, I have endeavored to make an analysis of the income-tax returns themselves, distinguishing in them what appears to be the income of idle capital from income which is derived not so much from the capital itself as from the labor bestowed in using the capital. Only the roughest estimate can be made, and the data, when we go back to 1843, are even more incomplete than they are now; but I have endeavored as far as possible to give everything to capital that ought to be given, and not to err on the side of assigning it too small a share. The whole of Schedule A is thus assigned to capital, although it is well known that not even in Schedule A is the income obtained without exertion and care and some risk of loss, which are entitled to remuneration. In Schedule D also I have allowed that all the income from public companies and foreign investments is from idle capital, although here the vigilance necessary and the risks attendant on the business are really most serious, and part of the so-called profit is not really interest on idle capital at all, but strictly the remuneration of labor. I have also rather exaggerated than depreciated the estimate for capital employed in trades and professions, my estimate being rather more than that of Mr. Dudley Baxter in his famous paper on the "National Income." With these explanations I submit the following estimate of the share of capital in the income-tax income at different dates:

Analysis of the Income-Tax Returns for the under-mentioned Years, showing the Estimated Income from Capital on the one side, and the Estimated Income from Wages of Superintendence and Salaries on the other side.

[In millions of pounds.]

	1881.		1862.		1843.	
	From capital.	From salaries, etc.	From capital.	From salaries, etc.	From capital.	From salaries, etc.
Schedule A—						
Lands, tithes, etc., exclusive of houses.......	70	nil	60	nil	57	nil
Messuages, etc.........	117	nil	62	nil	41	nil
Schedule B—						
Occupation of land.....	25*	44	22½	38½	20	36
Schedule C—...........	40	nil	29	nil	29	nil
" D (Part I)......	64†	100†	32	49	29½	46½
" D (" II)......	91	nil	47	nil	12	nil
" E.............	nil	33	nil	20	nil	11
	407	177	252½	107½	188½	93½

NOTE.—In the estimate for 1843, the figures assigned to Schedule A are only those of lands and tithes and houses to correspond with the existing Schedule A: and the figures of Schedule D include mines, quarries, railways, etc., now in Schedule D. An estimate is also made of the totals for Ireland, based on the returns of 1854, the total gross income under all the schedules thus estimated being about £30,000,000.

This estimate may be summarized as follows:

Summary of Analysis of Income-Tax Income in under-mentioned Years.

YEAR.	From capital.	From salaries, etc.	Total.
1843......................	£188,500,000	£93,500,000	£282,000,000
1862......................	252,500,000	107,500,000	360,000,000
1881......................	407,000,000	177,000,000	584,000,000

Thus a very large part of the increase of the income-tax income in the last forty years is not an increase of the income from capital at all in any proper sense of the word. On the contrary, the increase in the income from capital is only about two thirds of the total increase. This increase is, moreover, at a less rate than the increase of the capital itself, as appearing from the probate-duty returns,‡ a point which deserves special notice. The conclusion, therefore, is, that the working-classes have not been losing in the last fifty years through

* Interest on £500,000,000 of capital in 1881 at 5 per cent. In my paper on accumulations of capital, I estimated agricultural capital at a larger sum than this, but since then there has been some loss of agricultural capital, and, if a larger sum were taken, the rate of interest used in the calculation for the present purpose should be less.

† Estimating that the income here is worth four years' purchase, and that it may be capitalized at that rate; and then allowing that this capital earns 10 per cent, the rest being wages of superintendence or salaries.

‡ These returns, however, it should always be remembered, do not include real property.

the fruits of their labor being increasingly appropriated to capital. On the contrary, the income from capital has at least no more than kept pace with the increase of capital itself, while the increase of capital per head, as we have seen, is very little; so that it may be doubted whether the income of the individual capitalist from capital has on the average increased at all. If the return to capital had doubled, as the wages of the working-classes appear to have doubled, the aggregate income of the capitalist classes returned to the income-tax would now be £800,000,000 instead of £400,000,000. In other words, it would not be far short of the mark to say that almost the whole of the great material improvement of the last fifty years has gone to the masses. The share of capital is a very small one. And what has not gone to the workman, so called, has gone to remunerate people who are really workmen also, the persons whose incomes are returned under Schedule D as from "trades and professions." The capitalist as such gets a low interest for his money, and the aggregate return to capital is not a third part of the aggregate income of the country, which may be put at not less than £1,200,000,000, and is, I should estimate, not much more than a fourth part.

It will be interesting, I think, to present these conclusions in the form of an account. We have not, as I have already said, an exact statement of aggregate earnings, either at the beginning or at the end of the period; but assuming the aggregate income of the people as about £1,200,000,000 now, and that the wages of working-men are per head twice what they were, the aggregates in 1843 and at the present time would compare as follow:

Progress of National Income.

	Income in 1843.	Income at present time.	Increase.	
			Amount.	Per cent.
Capitalist classes from capital.	£190,000,000	£400,000,000	£210,000,000	110
Working income in income-tax returns.	90,000,000	180,000,000	90,000,000	100
Working income not in income-tax returns.	235,000,000	620,000,000	385,000,000	160
	£515,000,000	£1,200,000,000	£685,000,000	130

Progress of National Capital paying Probate Duty.

	1838.	Present time.	Increase.	
			Amount.	Per cent.
Amount of capital	£55,000,000	£140,000,000	£85,000,000	155
" per estate	2,200,000	2,500,000	300,000	14

NOTE.—Increase of working income per head, 100 per cent.

From this it appears that the increase of what is known as working-class income in the aggregate is greater than that of any other class, being 160 per cent, while the return to capital and the return to what are called the capitalist classes, whether it is from capital proper or, as I maintain, a return only in the nature of wages, has only increased about 100 per cent, although capital itself has increased over 150 per cent. At the same time the capitalist classes themselves have greatly increased in number, so that the amount of capital possessed among them per head has only increased 15 per cent, notwithstanding the great increase in capital itself, and the average income per head can have hardly increased at all. On the other hand, as the masses of the nation, taking the United Kingdom altogether, have only increased about 30 per cent since 1843, when these income-tax figures begin, while their aggregate incomes have increased 160 per cent, it is explained how these incomes have gained, individually, about 100 per cent as against hardly any increase at all in the incomes of what are called the capitalist classes, on the average. Thus the rich have become more numerous, but not richer individually; the "poor" are, to some smaller extent, fewer; and those who remain "poor" are, individually, twice as well off on the average as they were fifty years ago. The "poor" have thus had almost all the benefit of the great material advance of the last fifty years.

We may now conclude this long inquiry. It has been shown directly, I believe, that, while the individual incomes of the working-classes have largely increased, the prices of the main articles of their consumption have rather declined; and the inference as to their being much better off, which would be drawn from these facts, is fully supported by statistics showing a decline in the rate of mortality, an increase of the consumption of articles in general use, an improvement in general education, a diminution of crime and pauperism, a vast increase of the number of depositors in savings-banks, and other evidences of general well-being. Finally, the increase of the return to capital has not been in any way in proportion, the yield on the same amount of capital being less than it was, and the capital itself being more diffused, while the remuneration of labor has enormously increased. The facts are what we should have expected from the conditions of production in recent years. Inventions having been multiplied, and production having been increasingly efficient, while capital has been accumulated rapidly, it is the wages-receivers who must have the benefit. The competition of capital keeps profits down to the lowest point, and workmen consequently get for themselves nearly the whole product of the aggregate industry of the country. It is interesting, nevertheless, to find that the facts correspond with what theory should lead us to anticipate.

The moral is a very obvious one. Whatever may be said as to the ideal perfection or imperfection of the present economic *régime*, the fact of so great an advance having been possible for the masses of the people in the last half-century is encouraging. It is something to know that whether a better *régime* is conceivable or not, human nature being what it is now (and I am one of those who think that the *régime* is the best, the general result of a vast community living as the British nation does, with all the means of healthy life and civilization at command, being little short of a marvel if we only consider for a moment what vices of anarchy and misrule in society have had to be rooted out to make this marvel); still, whether best or not, it is something to know that vast improvement has been possible with this *régime.* Surely the lesson is that the nation ought to go on improving on the same lines, relaxing none of the efforts which have been so successful. Steady progress in the direction maintained for the last fifty years must soon make the English people vastly superior to what they are now.

I should like to add just one or two remarks bearing on questions of the moment, and as to the desirability or possibility of a change of *régime* now so much discussed, which the figures I have brought before you suggest. One is, that, apart from all objections of principle to schemes of confiscating capital—land nationalization, or collectivism, or whatever they may be called—the masses could not hope to have much to divide by any such schemes. Taking the income from capital at £400,000,000, we must not suppose that the whole of that would be divisible among the masses if capital were confiscated. What the capitalist classes spend is a very different thing from what they make. The annual savings of the country now exceed £200,000,000, being made as a rule, though not exclusively, by the capitalist classes. If, then, the £400,000,000 were to be confiscated, one of two things would happen—either the savings would not be made, in which case the condition of the working-classes would soon deteriorate, for everything depends upon the steady increase of capital; or the savings would be made, in which case the spending power of the masses would not be so very much increased. The difference would be that they would be owners of the capital, but the income would itself remain untouched. The system under which large capitals are in a few hands may, in fact, have its good side in this, that the Jay Goulds, Vanderbilts, and Rothschilds can not spend their income. The consequent accumulation of capital is, in fact, one of the reasons why the reward for labor is so high, and the masses get nearly all the benefit of the great increase of production. The other remark I have to make is that, if the object really aimed at by those who talk of land nationalization and the like is carried out, the people who will suffer are those who receive large wages. To effect what they intend, the agitators must not merely seize on the property of a few, they must confiscate what are as much earnings as those of a mechanic or a laborer, and the wages of the most skilled mechanics and artisans themselves. The agitation is, in fact, to level down, to diminish the reward of laborers who receive a large wage because they can do the work the community requires, the proof being that in a market without favor they get the wage, and to increase the reward of other laborers beyond what in the same free market the community would freely give them. Whether the production would be continued at all if there were any success in these attempts, common-sense will tell us. Those who have done some hard work in the world will, I am sure, agree with me that it is only done by virtue of the most powerful stimulants. Take away the rewards, and even the best would probably not give themselves up to doing what the community wants and now pays them for doing, but they would give themselves up either to idleness or to doing something else. The war of the land-nationalizer and socialist is then not so much with the capitalist as with the workman, and the importance of this fact should not be lost sight of.

AN EXPERIMENT IN PROHIBITION.

By EDWARD JOHNSON.

THE liquor question, like the poor, we have always with us ; and at present, as at almost any time for many years past, the best method of dealing with it is being actively discussed in many parts of the country. Public opinion seems to be divided between repressive and restrictive legislation ; and, in view of this fact and of the efforts of those who favor the prohibitory system to introduce it in localities where other methods have hitherto prevailed, the experience of Vermont, which has had a prohibitory liquor law for more than thirty years, furnishes an instructive lesson.

The Vermont law was passed by the Legislature of 1852. In the Legislature, as among the people, there was a close division of sentiment, the law finally passing by a vote of 91 to 90, and being ratified by the people of the State by a vote of 22,215 to 21,044—a popular majority of only 1,171 for the law. According to its terms, the law went into effect in March, 1853, and has ever remained the settled policy of the State. As originally enacted, it merely forebade the selling, furnishing, or giving away of intoxicating liquor, under mdoerate penalties, and provided for the appointment of an agent in each town, who should be authorized to sell liquor for medicinal and mechanical purposes, the profits of the sale accruing to the town. But, from the moment of its adoption until the present time, the advocates of the law have been continually engaged in enlarging its scope and strengthening its provisions. Each Legislature since 1853 has modified and amended the law in the direction of increased thoroughness, severity, and efficiency. Its supporters have indeed taken "Thorough" for their motto. Everything they have asked has been granted by successive Legislatures, and all possible measures have been taken to render the law perfect. As it now stands, it constitutes an entire chapter of the Revised Statutes, and embraces more than fourscore sections. A glance at its provisions will show that it is stringent enough to satisfy the most thorough-going believer in repressive legislation. It absolutely forbids the manufacture, sale, furnishing, or giving away of intoxicating liquors, among which malt-liquors and lager-beer are specifically included. Cider must not be sold at any place of public resort, nor may a man in his own house furnish any liquors to minors. The penalties in all these cases are a fine of ten dollars for the first offense, twenty dollars for the second, and three months in the House of Correction for the third. A "common seller" is to be fined one hundred dollars for the first offense, and two hundred dollars for the second, and for the third is to be committed to the House of Correction for four months. He may also be prosecuted for maintaining a nuisance, and in case of conviction he is to be fined from twenty dollars to two hundred dollars, and imprisoned from one month to three months; and his place of business is to be summarily closed, nor may he reopen it before furnishing a heavy bond to abandon the liquor-traffic. A person bringing, or assisting in bringing, liquor into the State, is to be fined twenty dollars for the first offense, and fifty for the second, and for the third is to be imprisoned for three months. A traveling liquor agent is to be fined one hundred dollars for the first offense of selling, and three hundred dollars for the second, and for the third is to be fined five hundred dollars and imprisoned for six months. All liquors kept, or supposed to be kept, for purposes forbidden by the statute, are to be seized by the police, who may for this purpose enter and search, without a warrant, any premises, public or private. A percentage of all fines imposed and collected is awarded the informer and the prosecuting officer. The statute furthermore contains provisions for the recovery of civil damages from liquor-dealers, for imposing a heavy fine upon one who rents premises to be used in the liquor-traffic, and for carrying out the design of the law in a thorough and efficient manner.

But the practical operation of this severe and sweeping law—there is the rub! It is a fact, which can not be controverted or denied, that for all practical purposes the law is an absolute dead letter. According to the returns of the United States revenue officers, the Government tax on the manufacture and sale of intoxicating liquors in the State amounted last year to fourteen thousand dollars in round numbers. On the same authority, there are in the State at the present time four hundred and forty-six places where intoxicating liquors are sold; and, though the population is well-nigh stationary, there is a marked increase in the number of these places, last year's returns showing only four hundred and twenty-six, and those for the preceding year four hundred and nine. In the city of Burlington there are about threescore places where liquor is sold, and in Rutland, St. Albans, and all the larger towns, a proportional number; and in every village in the State, with the exception of a few inconsiderable hamlets, there is at least one such place. A large proportion of the dram-shops are located upon the principal streets, and there is no concealment or attempted concealment of the illegal traffic conducted within them. As these facts and figures sufficiently indicate, the law, broadly speaking, is not at all enforced. The sale of liquor, it is hardly too much to say, is almost as free and open as though there were no such thing as a prohibitory law. The principal exception to the general rule consists of an occasional spasmodic attempt to enforce the law in the larger places, and the fining of liquor-dealers on what are termed "disclosures." In the latter case, a person arrested for intoxication is compelled to "disclose" the person of whom he procured liquor, and that person is then tried for the offense. Such cases are very common, but as only the lowest class of liquor-dealers is concerned in them, generally speaking, and as the prosecution is invariably for a "first offense," no effective purpose is served in repressing the liquor-traffic. In the larger towns, an effort to enforce the law is occasionally made, but such efforts have invariably proved short-lived, and in almost every instance the people have, at the earliest opportunity, rejected at the polls the officers who have attempted to enforce the law. These are the principal exceptions to the general rule of non-enforcement. Of enforcing the law as the laws against burglary and larceny are enforced, no one dreams for a moment. Such is the unsatisfactory result of Vermont's thirty years' experience of the prohibitory liquor law. One might go still further, and speak of the perjury and subornation of perjury, for which the law is in a sense responsible; of the disregard and contempt for all law which the operation of this law tends to foster and encourage, and of cognate matters which will occur to the reflective reader; but, perhaps, enough has been said in showing the failure of the law to accomplish the object for which it was enacted.

The cause of the failure of the law is not far to seek. It is obviously that the law is not sustained by public sentiment. It is that the world can not be dragooned into virtue. The supporters of the prohibitory law are well-meaning men and women, who are sincerely desirous of benefiting their fellow-human beings and advancing God's kingdom upon earth: but not even by these will humanity suffer itself to be driven to loftier heights of thought and action. The people of Vermont are not singular in this matter; and there would seem to be no reason why the prohibitory system, a failure in a moral, God-fearing community, should be successful anywhere in the United States.

THE MILK IN THE COCOA-NUT.

By GRANT ALLEN.

FOR many centuries the occult problem how to account for the milk in the cocoa-nut has awakened the profoundest interest alike of ingenious infancy and of maturer scientific age. Though it can not be truthfully affirmed of it, as of the cosmogony or creation of the world, in "The Vicar of Wakefield," that it "has puzzled the philosophers of all ages" (for Sanchoniathon was certainly ignorant of the very existence of that delicious juice, and Manetho doubtless went to his grave without ever having tasted it fresh from the nut under a tropical veranda), yet it may be safely asserted that for the last three hundred years the philosopher who has not at some time or other of his life meditated upon that abstruse question, is unworthy of such an exalted name. The cosmogony and the milk in the cocoa-nut are, however, a great deal closer together in thought than Sanchoniathon or Manetho, or the rogue who quoted them so glibly, is ever at all likely, in his wildest moments, to have imagined.

The cocoa-nut, in fact, is a subject well deserving of the most sympathetic treatment at the gentle hands of grateful humanity. No other plant is useful to us in so many diverse and remarkable manners. It has been truly said of that friend of man, the domestic pig, that he is all good, from the end of his snout to the tip of his tail; but even the pig, though he furnishes us with so many necessaries or luxuries—from tooth-brushes to sausages, from ham to lard, from pepsine-wine to pork pies—does not nearly approach, in the multiplicity and variety of his virtues, the all-sufficing and world-supplying cocoa-nut. A Chinese proverb says that there are as many useful properties in the cocoa-nut palm as there are days in the year; and a Polynesian saying tells us that the man who plants a cocoa-nut plants meat and drink, hearth and home, vessels and clothing, for himself and his children after him. Like the great Mr. Whiteley, the invaluable palm-tree might modestly advertise itself as a universal provider. The solid part of the nut supplies food almost alone to thousands of people daily, and the milk serves them for drink, thus acting as an efficient filter to the water absorbed by the roots in the most polluted or malarious regions. If you tap the flower-stalk you get a sweet juice, which can be boiled down into the peculiar sugar called (in the charming dialect of commerce) jaggery; or it can be fermented into a very nasty spirit known as palm-wine, toddy, or arrack; or it can be mixed with bitter herbs and roots to make that delectable compound "native beer." If you squeeze the dry nut you get cocoa-nut oil, which is as good as lard for frying when fresh, and is "an excellent substitute for butter at breakfast," on tropical tables. Under the mysterious name of copra (which most of us have seen with awe described in the market reports as "firm" or "weak," "receding" or "steady") it forms the main or only export of many oceanic islands, and is largely imported into this realm of England, where the thicker portion is called stearine, and used for making sundry candles with fanciful names, while the clear oil is employed for burning in ordinary lamps. In the process of purification, it yields glycerine; and it enters largely into the manufacture of most better-class soaps. The fiber that surrounds the nut makes up the other mysterious article of commerce known as coir, which is twisted into stout ropes, or woven into cocoa-nut matting and ordinary door-mats. Brushes and brooms are also made of it, and it is used, not always in the most honest fashion, in place of real horse-hair, in stuffing cushions. The shell, cut in half, supplies good cups, and is artistically carved by the Polynesians, Japanese, Hindoos, and other benighted heathen, who have not yet learned the true methods of civilized machine-made shoddy manufacture. The leaves serve as excellent thatch; on the flat blades, prepared like papyrus, the most famous Buddhist manuscripts are written; the long mid-ribs or branches (strictly speaking, the leaf-stalks) answer admirably for rafters, posts, or fencing; the fibrous sheath at the base is a remarkable natural imitation of cloth, employed for strainers, wrappers, and native hats; while the trunk, or stem, passes in carpentry under the name of porcupine-wood, and produces beautiful effects as a wonderfully-colored cabinet-maker's material. These are only a few selected instances out of the innumerable uses of the cocoa-nut palm.

Apart even from the manifold merits of the tree that bears it, the milk itself has many and great claims to our respect and esteem, as everybody who has ever drunk it in its native surroundings will enthusiastically admit. In England, to be sure, the white milk in the dry nuts is a very poor stuff, sickly, and strong-flavored and rather indigestible. But in the tropics, cocoa-nut milk, or, as we oftener call it there, cocoa-nut water, is a very different and vastly superior sort of beverage. At eleven o'clock every morning, when you are hot and tired with the day's work, your black servant, clad from head to foot in his cool clean white linen suit, brings you in a tall soda-glass full of a clear, light, crystal liquid, temptingly displayed against the yellow background of a chased Benares brass-work tray. The lump of ice bobs enticingly up and down in the center of the tumbler, or clinks musically against the edge of the glass as he carries it along. You take the cool cup thankfully and swallow it down at one long draught; fresh as a May morning, pure as an English hill-side spring, delicate as—well, as cocoa-nut water. None but itself can be its parallel. It is certainly the most delicious, dainty, transparent, crystal drink ever invented. How did it get there, and what is it for?

In the early green stage at which cocoa-nuts are generally picked for household use in the tropics, the shell hasn't yet solidified into a hard, stony coat, but still remains quite soft enough to be readily cut through with a sharp table-knife—just like young walnuts picked for pickling. If you cut one across while it's in this unsophisticated state, it is easy enough to see the arrangement of the interior, and the part borne by the milk in the development and growth of the mature nut. The ordinary tropical way of opening cocoa-nuts for table, indeed, is by cutting off the top of the shell and rind in successive slices, at the end where the three pores are situated, until you reach the level of the water, which fills up the whole interior. The nutty part around the inside of the shell is then extremely soft and jelly-like, so that it can be readily eaten with a spoon : but as a matter of fact very few people ever do eat the flesh at all. After their first few months in the tropics, they lose the taste for this comparatively indigestible part, and confine themselves entirely (like patients at a German spa) to drinking the water. A young cocoa-nut is thus seen to consist, first of a green outer skin, then of a fibrous coat, which afterward becomes the hair, and next of a harder shell which finally gets quite woody ; while inside all comes the actual seed or unripe nut itself. The office of the cocoa-nut water is the deposition of the nutty part around the side of the shell ; it is, so to speak, the mother-liquid, from which the harder eatable portion is afterward derived. This state is not uncommon in embryo seeds. In a very young pea, for example, the inside is quite watery, and only the outer skin is at all solid, as we have all observed when green peas first come into season. But the special peculiarity of the cocoa-nut consists in the fact that this liquid condition of the interior continues even after the nut is ripe, and that is the really curious point about the milk in the cocoa-nut which does actually need accounting for.

In order to understand it one ought to examine a cocoa-nut in the act of budding, and to do this it is by no means necessary to visit the West Indies or the Pacific Islands ; all you need to do is to ask a Covent Garden fruit-salesman to get you a few "growers." On the voyage to England, a certain number of precocious cocoa-nuts, stimulated by the congenial warmth and damp of most ship-holds, usually begin to sprout before their time ; and these waste nuts are sold by the dealers at a low rate to East End children and inquiring botanists An examination of a "grower" very soon convinces one what is the use of the milk in the cocoa-nut.

It must be duly borne in mind, to begin with, that the prime end and object of the nut is not to be eaten raw by the ingenious monkey, or to be converted by lordly man into cocoa-nut biscuits, or cocoa-nut pudding, but simply and solely to reproduce the cocoa-nut palm in sufficient numbers to future generations. For this purpose the nut has slowly acquired by natural selection a number of protective defenses against its numerous enemies, which serve to guard it admirably in the native state from almost all possible animal depredators. First of all, the actual nut or seed itself consists of a tiny embryo plant, placed just inside the softest of the three pores or pits at the end of the shell, and surrounded by a vast quantity of nutritious pulp, destined to feed and support it during its earliest unprotected days, if not otherwise diverted by man or monkey. But, as whatever feeds a young plant will also feed an animal, and as many animals betray a felonious desire to appropriate to their own wicked ends the food-stuffs laid up by the palm for the use of its own seedling, the cocoa-nut has been compelled to inclose this particularly large and rich kernel in a very solid and defensive shell. And, once more, since the palm grows at a very great height from the ground—I have seen them up to ninety feet in favorable circumstances—this shell stands a very good chance of getting broken in tumbling to the earth, so that it has been necessary to surround it with a mass of soft and yielding fibrous material, which breaks its fall, and acts as a buffer to it when it comes in contact with the soil beneath. So many protections has the cocoa-nut gradually devised for itself by the continuous survival of the best adapted among numberless and endless spontaneous variations of all its kind in past time.

Now, when the cocoa-nut has actually reached the ground at last, and proceeds to sprout in the spot where chance (perhaps in the bodily shape of a disappointed monkey) has chosen to cast it, these numerous safeguards and solid envelopes naturally begin to prove decided nuisances to the embryo within. It starts under the great disadvantage of being hermetically sealed within a solid wooden shell, so that no water can possibly get at it to aid it as most other seeds are aided in the process of germination. Fancy yourself a seed-pea, anxious to sprout, but coated all round with a hard covering of impermeable sealing-wax, and you will be in a position faintly to appreciate the unfortunate predicament of a grower cocoa-nut. Natural selection, however—that *deus ex machina* of modern science, which can perform such endless wonders, if only you give it time enough to work in and variations enough to work upon—natural selection has come to the rescue of the unhappy plant by leaving it a little hole at the top of the shell, out of which it can push its feathery green head without difficulty. Everybody knows that if you look at the sharp end of a cocoa-nut you will see three little brown pits or depressions on its surface. Most people also know that two of these are firmly stopped up (for a reason to which I shall presently recur), but that the third one is only closed by a slight film or very thin shell, which can be easily bored through with a pocket-knife, so as to let the milk run off before cracking the shell. So much we have all learned during our ardent pursuit of natural knowledge on half-holidays in early life. But we probably then failed to observe that just opposite this soft hole lies a small, roundish knob, imbedded in the pulp or eatable portion, which knob is in fact the embryo palm or seedling, for whose ultimate benefit the whole arrangement (in brown and green) has been invented. That is very much the way with man: he notices what concerns his own appetite, and omits all the really important parts of the whole subject. *We* think the use of the hole is to let out the milk; but the nut knows that its real object is to let out the seedling. The knob grows out at last into the young plantlet, and it is by means of the soft hole that it makes its escape through the shell to the air and the sunshine which it seeks without.

This brings us really down at last to the true *raison d'être* for the milk in the cocoa-nut. As the seed or kernel can not easily get at much water from outside, it has a good supply of water laid up for it ready beforehand within its own encircling shell. The mother-liquid from which the pulp or nutty part has been deposited remains in the center, as the milk, till the tiny embryo begins to sprout. As soon as it does so, the little knob which was at first so very small enlarges rapidly and absorbs the water, till it grows out into a big, spongy cellular mass, which at last almost fills up the entire shell. At the same time, its other end pushes its way out through the soft hole, and then gives birth to a growing bud at the top—the future stem and leaves—and to a number of long threads beneath—the future roots. Meanwhile, the spongy mass inside begins gradually to absorb all the nutty part, using up its oils and starches for the purpose of feeding the young plant above, until it is of an age to expand its leaves to the open tropical sunlight and shift for itself in the struggle for life. It seems at first sight very hard to understand how any tissue so solid as the pulp of cocoa-nut can be thus softened and absorbed without any visible cause; but in the subtile chemistry of living vegetation such a transformation is comparatively simple and easy to perform. Nature sometimes works much greater miracles than this in the same way: for example, what is called vegetable ivory, a substance so solid that it can be carved or turned only with great difficulty, is really the kernel of another palm-nut, allied to the cocoa-palm, and its very stony particles are all similarly absorbed during germination by the dissolving power of the young seedling.

Why, however, has the cocoa-nut three pores at the top instead of one, and why are two out of the three so carefully and firmly sealed up? The explanation of this strange peculiarity is only to be found in the ancestral history of the cocoa-nut kind. Most nuts, indeed, start in their earlier stage as if they meant to produce two or more seeds each; but, as they ripen, all the seeds except one become abortive. The almond, for example, has in the flower two seeds or kernels to each nut; but in the ripe state there is generally only one, though occasionally we find an almond with two—a philopena, as we commonly call it—just to keep in memory the original arrangement of its earlier ancestors. The reason for this is that plants whose fruits have no special protection for their seeds are obliged to produce a great many of them at once, in order that one seed in a thousand may finally survive the onslaughts of their Argus-eyed enemies ; but, when they learn to protect themselves by hard coverings from birds and beasts, they can dispense with some of these supernumerary seeds, and put more nutriment into each one of those that they still retain. Compare, for example, the innumerable small round seedlets of the poppy-head with the solitary large and richly-stored seed of the walnut, or the tiny black specks of mustard and cress with the single compact and well-filled seed of the filbert and the acorn. To the very end, however, most nuts begin in the flower as if they meant to produce a whole capsuleful of small unstored and unprotected seeds, like their original ancestors ; it is only at the last moment that they recollect themselves, suppress all their ovules except one, and store that one with all the best and oiliest food-stuffs at their disposal. The nuts, in fact, have learned by long experience that it is better to be the only son and heir of a wealthy house, set up in life with a good capital to begin upon, than to be one of a poor family of thirteen needy and unprovided children.

Now, the cocoa-nuts are descended from a great tribe—the palms and lilies—which have as their main distinguishing peculiarity the arrangement of parts in their flowers and fruits by threes each. For example, in the most typical flowers of this great group, there are three green outer calyx-pieces, three bright-colored petals, three long outer stamens, three short inner stamens, three valves to the capsule, and three seeds or three rows of seeds in each fruit. Many palms still keep pretty well to this primitive arrangement, but a few of them which have specially protected or highly developed fruits or nuts have lost in their later stages the threefold disposition in the fruit, and possess only one seed, often a very large one. There is no better and more typical nut in the whole world than a cocoa-nut—that is to say, from our present point of view at least, though the fear of that awful person, the botanical Smelfungus, compels me to add that this is not quite technically true. Smelfungus, indeed, would insist upon it that the cocoa-nut is not a nut at all, and would thrill us with the delightful information, innocently conveyed in that delicious dialect of which he is so great a master, that it is really " a drupaceous fruit with a fibrous mesocarp." Still, in spite of Smelfungus with his nice, hair-splitting distinctions, it remains true that humanity at large will still call a nut a nut, and that the cocoa-nut is the highest known development of the peculiar nutty tactics. It has the largest and most richly stored seed of any known plant ; and this seed is surrounded by one of the hardest and most unmanageable of any known shells. Hence the cocoa-nut has readily been able to dispense with the three kernels which each nut used in its earlier and less developed days to produce. But though the palm has thus taken to reducing the number of its seeds in each fruit to the lowest possible point consistent with its continued existence at all, it still goes on retaining many signs of its ancient threefold arrangement. The ancestral and most deeply ingrained habits persist in the earlier stages; it is only in the mature form that the later acquired habits begin fully to predominate. Even so our own boys pass through an essentially savage childhood of ogres and fairies, bows and arrows, sugar-plums and barbaric nursery tales, as well as a romantic boyhood of mediæval chivalry and adventure, before they steady down into that crowning glory of our race, the solid, sober, matter-of-fact, commercial British Philistine. Hence the cocoa-nut in its unstripped state is roughly triangular in form, its angles answerimg to the separate three fruits of simpler palms; and it has three pits or weak places in the shell, through which the embryos of the three original kernels used to force their way out. But as only one of them is now needed, that one alone is left soft; the other two, which would be merely a source of weakness to the plant if unprotected, are covered in the existing nut by harder shell. Doubtless they serve in part to deceive the too inquisitive monkey or other enemy, who probably concludes that, if one of the pits is hard and impermeable, the other two are so likewise.

Though I have now, I hope, satisfactorily accounted for the milk in the cocoa-nut, and incidentally for some other matters in its economy as well, I am loath to leave the young seedling, whom I have brought so far on his way, to the tender mercies of the winds and storms and tropical animals, some of whom are extremely fond of his juicy and delicate shoots. Indeed, the growing point or bud of most palms is a very pleasant succulent vegetable, and one kind—the West Indian mountain-cabbage—deserves a better and more justly descriptive name, for it is really much more like seakale or asparagus. I shall try to follow our young seedling on in life, therefore, so as to give, while I am about it, a fairly comprehensive and complete biography of a single flourishing cocoa-nut palm.

Beginning, then, with the fall of the nut from the parent-tree, the troubles of the future palm confront it at once in the shape of the nut-eating crab. This evil-disposed crustacean is common around the sea-coast of the Eastern tropical islands, which is also the region mainly affected by the cocoa-nut palm; for cocoa-nuts are essentially shore-loving trees, and thrive best in the immediate neighborhood of the sea. Among the fallen nuts, the clumsy-looking thief of a crab (his appropriate Latin name is *Birgus latro*) makes great and dreaded havoc. To assist him in his unlawful object he has developed a pair of front legs, with specially strong and heavy claws, supplemented by a last or tail-end pair armed only with very narrow and slender pincers. He subsists entirely upon a cocoa-nut diet. Setting to work upon a big fallen nut—with the husk on, cocoa-nuts measure in the raw state about twelve inches the long way—he tears off all the coarse fiber bit by bit, and gets down at last to the hard shell. Then he hammers away with his heavy claw on the softest eye-hole till he has pounded an opening right through it. This done he twists round his body so as to turn his back upon the cocoa-nut he is operating upon (crabs are never famous either for good manners or gracefulness) and proceeds awkwardly but effectually to extract all the white kernel or pulp through the breach with his narrow pair of hind pincers. Like man, too, the robber-crab knows the value of the outer husk as well as of the eatable nut itself, for he collects the fiber in surprising quantities to line his burrow and lies upon it, the clumsy sybarite, for a luxurious couch. Alas, however, for the helplessness of crabs and the rapacity and cunning of all-appropriating man! The spoil-sport Malay digs up the nest for the sake of the fiber it contains, which spares him the trouble of picking junk on his own account, and then he eats the industrious crab who has laid it all up, while he melts down the great lump of fat under the robber's capacious tail, and sometimes gets from it as much as a good quart of what may be practically considered as limpid cocoa-nut oil. *Sic vos non vobis* is certainly the melancholy refrain of all natural history. The cocoa-nut palm intends the oil for the nourishment of its own seedling; the crab feloniously appropriates it and stores it up under his capacious tail for future personal use; the Malay steals it again from the thief for his own purposes; and ten to one the Dutch or English merchant beguiles it from him with sized calico or poisoned rum, and transmits it to Europe, where it serves to lighten our nights and assist at our matutinal tub, to point a moral and adorn the present tale.

If, however, our cocoa-nut is lucky enough to escape the robber-crabs, the pigs, and the monkeys, as well as to avoid falling into the hands of man, and being converted into the copra of commerce, or sold from a costermonger's barrow in the chilly streets of ungenial London at a penny a slice, it may very probably succeed in germinating after the fashion I have already described, and pushing up its head through the surrounding foliage to the sunlight above. As a rule, the cocoa-nut has been dropped by its mother-tree on the sandy soil of a sea-beach; and this is the spot it best loves, and where it grows to the stateliest height. Sometimes, however, it falls into the sea itself, and then the loose husk buoys it up, so that it floats away bravely till it is cast by the waves upon some distant coral reef or desert island. It is this power of floating and surviving a long voyage that has dispersed the cocoa-nut so widely among oceanic islands, where so few plants are generally to be found. Indeed, on many atolls or isolated reefs (for example, on Keeling Island) it is the only tree or shrub that grows in any quantity, and on it the pigs, the poultry, the ducks, and the land-crabs of the place entirely subsist. In any case, wherever it happens to strike, the young cocoa-nut sends up at first a fine rosette of big, spreading leaves, not raised as afterward on a tall stem, but springing direct from the ground in a wide circle, something like a very big and graceful fern. In this early stage nothing can be more beautiful or more essentially tropical in appearance than a plantation of young cocoa-nuts. Their long, feathery leaves spreading out in great clumps from the buried stock, and waving with lithe motion before the strong sea-breeze of the Indies, are the very embodiment of those deceptive ideal tropics which, alas! are to be found in actual reality nowhere on earth save in the artificial palm-houses at Kew, and the Casino Gardens at too entrancing Monte Carlo.

For the first two or three years the young palms must be well watered, and the soil around them opened; after which the tall, graceful stem begins to rise rapidly into the open air. In this condition it may be literally said to make the tropics—those fallacious tropics, I mean, of painters and poets, of "Enoch Arden" and of "Locksley Hall." You may observe that, whenever an artist wants to make a tropical picture, he puts a group of cocoa-nut palms in the foreground, as much as to say, "You see there's no deception; these are the genuine, unadulterated tropics." But as to painting the tropics without the palms, he might just as well think of painting the desert without the camels. At eight or ten years old the tree flowers, bearing blossoms of the ordinary palm-type, degraded likenesses of the lilies and yuccas, greenish and inconspicuous, but visited by insects for the sake of their pollen. The flower, however, is fertilized by the wind, which carries the pollen-grains from one bunch of blossoms to another. Then the nuts gradually swell out to an enormous size, and ripen very slowly, even under the brilliant tropical sun. (I will admit that the tropics are hot, though in other respects I hold them to be arrant impostors, like that precocious American youth who announced on his tenth birthday that in his opinion life wasn't all that it was cracked up to be.) But the worst thing about the cocoa-nut palm, the missionaries always say, is the fatal fact that, when once fairly started, it goes on bearing fruit uninterruptedly for forty years. This is very immoral and wrong of the ill-conditioned tree, because it encourages the idyllic Polynesian to lie under the palms all day long, cooling his limbs in the sea occasionally, sporting with Amaryllis in the shade, or with the tangles of Neæra's hair, and waiting for the nuts to drop down in due time, when he ought (according to European notions) to be killing himself with hard work under a blazing sky, raising cotton, sugar, indigo, and coffee, for the immediate benefit of the white merchant, and the ultimate advantage of the British public. It doesn't enforce habits of steady industry and perseverance, the good missionaries say; it doesn't induce the native to feel that burning desire for Manchester piece-goods and the other blessings of civilization which ought properly to accompany the propagation of the missionary in foreign parts. You stick your nut in the sand; you sit by a few years and watch it growing; you pick up the ripe fruits as they fall from the tree; and you sell them at last for illimitable red cloth to the Manchester piece-goods merchant. Nothing could be more simple or more satisfactory. And yet it is difficult to see the precise moral distinction between the owner of a cocoa-nut grove in the South-Sea Islands and the owner of a coal-mine or a big estate in commercial England. Each lounges decorously through life after his own fashion; only the one lounges in a Russia-leather chair at a club in Pall Mall, while the other lounges in a nice soft dust-heap beside a rolling surf in Tahiti or the Hawaiian Archipelago.

Cnriously enough, at a little distance from the sandy levels or alluvial flats of the sea-shore, the sea-loving cocoa-nut will not bring its nuts to perfection. It will grow, indeed, but it will not thrive or fruit in due season. On the coast-line of Southern India, immense groves of cocoa-nuts fringe the shore for miles and miles together; and in some parts, as in Travancore, they form the chief agricultural staple of the whole country. "The state has hence facetiously been called Cocoanutcore," says its historian; which charmingly illustrates the true Anglo-Indian notion of what constitutes facetiousness, and ought to strike the last nail into the coffin of a competitive examination system. A good tree in full bearing should produce one hundred and twenty cocoa-nuts in a season; so that a very small grove is quite sufficient to maintain a respectable family in decency and comfort. Ah, what a mistake the English climate made when it left off its primitive warmth of the Tertiary period, and got chilled by the ice and snow of the Glacial epoch down to its present misty and dreary wheat-growing condition! If it were not for that, those odious habits of steady industry and perseverance might never have been developed in ourselves at all, and we might be lazily picking copra off our own cocoa-palms, to this day, to export in return for the piece-goods of some Arctic Manchester situated somewhere about the north of Spitzbergen or the New Siberian Islands.

Even as things stand at the present day, however, it is wonderful how much use we modern Englishmen now make in our own houses of this far Eastern nut, whose very name still bears upon its face the impress of its originally savage origin. From morning to night we never leave off being indebted to it. We wash with it as old brown Windsor or glycerine soap the moment we leave our beds. We walk across our passages on the mats made from its fiber. We sweep our rooms with its brushes, and wipe our feet on it as we enter our doors. As rope, it ties up our trunks and packages; in the hands of the house-maids it scrubs our floors; or else, woven into coarse cloth, it acts as a covering for bales and furniture sent by rail or steamboat. The confectioner undermines our digestion in early life with cocoa-nut candy; the cook tempts us later on with cocoa-nut cake; and Messrs. Huntley and Palmer cordially invite us to complete the ruin with cocoa-nut biscuits. We anoint our chapped hands with one of its preparations after washing; and grease the wheels of our carriages with another to make them run smoothly. Finally, we use the oil to burn in our reading-lamps, and light ourselves at last to bed with stearine-candles. Altogether, an amateur census of a single small English cottage results in the startling discovery that it contains twenty-seven distinct articles which owe their origin in one way or another to the cocoa-nut palm. And yet we affect, in our black ingratitude, to despise the question of the milk in the cocoa-nut.—*Cornhill Magazine.*

LONGEVITY OF ASTRONOMERS.

By Dr. A. B. M. LANCASTER.

THE average length of human life in civilized countries is calculated to be about thirty-three years. This mean applies to the whole of the population of a country. But certain distinctions may be made, between different professions for example, among which considerable variations are observable. It is easy to believe that some professions would have the general effect of increasing the probable duration of life, while others would abridge it. It is generally admitted that men devoted to scientific pursuits enjoy the expectation of a considerably longer life than the average. We have been curious enough to inquire how much foundation for this opinion there is in the case of astronomers, whose observations, calculations, and studies imperiously require a quiet, sedentary, and regular life. Our investigation has been facilitated by MM. Houzeau and Lancaster's "Bibliographie Générale de l'Astronomie," in the biographical chapter of which we found all the information we needed. In this chapter are given the date of birth and death of 1,741 astronomers, of periods reaching from the most ancient times to our own days. Calculating the mean length of life of the whole 1,741, we have found it to be sixty-four years and three months. Fully to appreciate the value of this figure, we must compare it with that representing the average expectation of life at the age at which the astronomer may be supposed to have begun his career. If we fix this age at eighteen years, the person enjoys an average expectation, according to the mortality-tables, of living to sixty-one years. The astronomer, then, enjoys an advantage equivalent to an additional expectation of three years and three months. If we examine the ages to which they actually lived, we find that, out of a thousand astronomers, 596 lived to be seventy years old; 260 to between seventy and seventy-nine; 126 to between eighty and eighty-nine; 15 to between ninety and ninety-nine; and three to be over a hundred years old.

Taking a population in mass, say that of Belgium, of a thousand persons having reached the age of eighteen years, there die 944 before they are seventy years old ; 42 between seventy and seventy-nine ; 13 between eighty and eighty-nine ; and one between ninety and ninety-nine. The divergencies between the two groups are very evident.

If we limit our investigations to a purely intellectual domain—that is, if we confine the examination to scientific and literary men and artists—we shall find that the chances of life are greatest with the first and least with the last. A. Quetelet has, in his "Anthropometrie," made a comparison on this point between the most famous men of antiquity and of modern times, and has found that the mean life of fourteen most illustrious artists was fifty-nine years and four months ; of twenty-four literary men, sixty-five years and six months ; and of twenty-two scientific men and philosophers, seventy-three years and eleven months. On our own side, we have made a selection of the twenty-three most celebrated astronomers, and have found their average term of life to be seventy-one years and eleven months. The duration of life among these different classes of men of intellectual life varies, as we have seen, when we pass from one to the other. The variations depend both on external conditions peculiar to each of them, and upon the objects of their labors and studies. The two causes are in fact connected, the first proceeding naturally from the second.

Professor P. Riccardi, in his "Biblioteca Matematica Italiana," gives a table of the average life of the mathematicians of Italy, in the order of their fame. He has arranged his mathematicians in four categories, comprising : 1. The three most illustrious names (Archimedes, Galileo, and Lagrange). 2. Forty-seven mathematicians of great reputation. 3. Fifty of the second rank. 4. Three hundred and eighty of the third rank. The average duration of life in these categories of mathematicians was—1. Seventy-six years and eight months. 2. Sixty-nine years and five months. 3. Sixty-six years and four months. 4. Sixty-five years and ten months.

The fame of a scientific man being generally in proportion to the industry with which he works, we may draw our inferences from these facts as to the relations between activity and duration of life.

Another interesting fact has been brought out in our researches for this article. The excitement of the life of our age and the consequent diminution of its length have been frequently spoken of. We do not live as long as formerly, it is said, but we live more rapidly. The latter hypothesis may be true, but the former one is certainly false, as statistics have demonstrated for the present century. In Belgium, among other countries, the mean of life, which, during the period from 1841 to 1845, was thirty-one years and three months, was lengthened to thirty-three years in the lustrum from 1871 to 1875. A similar difference has been observed in other countries. Data for comparison are scarce for centuries previous to the present one, but our statistics of the lives of astronomers may give us some information on this point.

We have determined the average length of life of the adepts of the science of the sky who died before 1780 and of those who have died since that year. We have obtained sixty-three years and six months for the former, and sixty-four years and eleven months for the latter. The advantage in favor of these is not to be despised.

Taking a hundred individuals in each of these categories, there died at different ages:

	Before 1870.	After 1870.
Before seventy years of age	62	57
Between seventy and seventy-nine	23	28
Between eighty and eighty-nine	12	13
Between ninety and ninety-nine	2	2
Over a hundred	1	0

The conclusion at which we arrive has already probably occurred to more than one reader. Become an astronomer, if you wish to live long. We will add, whoever follows this counsel will not only see the limits of his life far removed, but he will also find in the study and contemplation of the heavenly bodies a satisfaction more durable than any earthly pleasures.—*Translated for the Popular Science Monthly from Ciel et Terre.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXVIII.

I NOW proceed to examine the chemical changes which occur in the course of the cookery of vegetable substances used for food. My readers will remember that I referred to Haller's statement, "*Dimidium corporis humani gluten est,*" which applies to animals generally, viz., that half of their substance is gelatine, or that which by cookery becomes gelatine. This abundance depends upon the fact that the walls of the cells and the framework of the tissues are composed of this material.

In the vegetable structure we encounter a close analogy to this. Cellular structure is still more clearly defined than in the animal, as may be easily seen with the help of a very moderate microscopic power. Pluck one of the fibrils that you see shooting down into the water of the hyacinth-glasses just at this season, or, failing one of these, any other succulent rootlet. Crush it between two pieces of glass, and examine. At the end there is a loose, spongy mass of round cells; these merge into oblong rectangular cells surrounding a central axis of spiral tube or tubes, or greatly elongated cell-structure. Take a thin slice of stem, or leaf, or flower, or bark, or pith, examine in like manner, and cellular structure of some kind will display itself, clearly demonstrating that whatever may be the contents of these round, oval, hexagonal, oblong, or otherwise regular and irregular cells, we can not cook and eat any whole vegetable, or slice of vegetable, without encountering a large quantity of cell-wall. It constitutes far more than half of the substance of most vegetables, and therefore demands prominent consideration. It exists in many forms with widely-differing physical properties, but with very little variation in chemical composition—so little, that in many chemical treatises cellular tissue, cellulose, lignin, and woody fiber are treated as chemically synonymous. Thus, Miller says: "Cellular tissue forms the groundwork of every plant, and when obtained in a pure state its composition is the same, whatever may have been the nature of the plants which furnished it, though it may vary greatly in appearance and physical characters; thus, it is loose and spongy in the succulent shoots of germinating seeds, and in the roots of plants, such as the turnip and the potato; it is porous and elastic in the pith of the rush and the elder; it is flexible and tenacious in the fibers of hemp and flax; it is compact in the branches and wood of growing trees; and becomes very hard and dense in the shells of the filbert, the peach, the cocoanut, and the *Phytelephas* or vegetable ivory."

Its composition in all these cases is that of a *carbohydrate*, i. e., carbon united with the elements of water, which, by-the-way, should not be confounded with a *hydrocarbon*, or compound of carbon with hydrogen simply, such as petroleum, fats, essential oils, and resins. There is, however, some little chemical difference between wooden tissue and the pure cellulose that we have in finely-carded cotton, in linen, and pure paper-pulp, such as is used in making the filtering-paper for chemical laboratories, which burns without leaving a weighable quantity of ash. The woody forms of cellular tissue owe their characteristic properties to an incrustation of *lignin*, which is often described as synonymous with cellulose, but is not so. It is composed of carbon, oxygen, and hydrogen, like cellulose, but the hydrogen is in excess of the proportion required to form water by combination with the oxygen.

My own view of the composition of this incrustation (lignin properly so called) is that it consists of a carbohydrate united with a hydrocarbon, the latter having a resinous character; but whether the hydrocarbon is chemically combined with the carbohydrate (the resin with the cellulose), or whether the resin only mechanically envelops and indurates the cellulose I will not venture to decide, though I incline to the latter view. As we shall presently see, this view of the constitution of the indurated forms of cellular tissue has an important practical bearing upon my present subject. To indicate this beforehand I will put it grossly as opening the question of whether a very advanced refinement of scientific cookery may or may not enable us to convert nut-shells, wood-shavings, and sawdust into wholesome and digestible food. I have no doubt whatever that it may. It could be done at once if the incrusting resinous matter were removed, for pure cellulose in the form of cotton and linen rags has been converted into sugar artificially in the laboratory of the chemist; and in the ripening of fruits such conversion is effected on a large scale in the laboratory of Nature. A Jersey pear, for example, when full grown in autumn is little better than a lump of acidulated wood. Left hanging on the leafless tree, or gathered and carefully stored for two or three months, it becomes by Nature's own unaided cookery the most delicious and delicate pulp that can be tasted or imagined.

Certain animals have a remarkable power of digesting ligneous tissue. The beaver is an example of this. The whole of its stomach, and more especially that secondary stomach the *cæcum*, is often found crammed or plugged with fragments of wood and bark. I have opened the crops of several Norwegian ptarmigans, and found them filled with no other food than the needles of pines, upon which they evidently feed during the winter. The birds, when cooked, were scarcely eatable on account of the strong resinous flavor of their flesh.

I may here, by-the-way, correct the commonly-accepted version of a popular story. We are told that when Marie Antoinette was informed of a famine in the neighborhood of the Tyrol, and of the starving of some of the peasants there, she replied, "I would rather eat pie-crust" (some of the story-tellers say "pastry") "than starve." Thereupon the courtiers giggled at the ignorance of the pampered princess who supposed that starving peasants had such an alternative food as pastry. The ignorance, however, was all on the side of the courtiers and those who repeat the story in its ordinary form. The princess was the only person in the court who really understood the habits of the peasants of the particular district in question. They cook their meat, chiefly young veal, by rolling it in a kind of dough made of sawdust, mixed with as little coarse flour as will hold it together; then place this in an oven or in wood-embers until the dough is hardened to a tough crust, and the meat is raised throughout to the cooking-point. Marie Antoinette said that she would rather eat *croutins* than starve, knowing that these *croutins*, or meat pie-crusts, were given to the pigs; that the pigs digested them, and were nourished by them in spite of the wood-sawdust.

When I come to the other constituents of vegetable food it will be understood that the changes effected in their cookery are but nominal, and that nearly the whole business of vegetable cookery consists in rendering the cellular tissue more digestible than it is in the raw state; or in breaking it up to liberate its contents. When on the subject of cooking animal food, I had to define the cooking temperature as determined by that at which albumen coagulates, and to point out the mischief arising from exceeding that temperature and thus rendering the albumen horny and indigestible.

No such precautions are demanded in the boiling of vegetables. The work to be done in cooking a cabbage or a turnip, for example, is merely to soften the cellular tissue by the semi-solvent action of hot water; there is nothing to avoid in the direction of overheating. Even if the water could be raised above 212°, the vegetable would be rather improved than injured thereby.

The question that now naturally arises is, whether modern science can show us that anything more can be done in the preparation of vegetable tissue than the mere softening in boiling water. In my first paper I said that the practice of using the digestive apparatus of sheep, oxen, etc., for the preparation of our food is merely a transitory barbarism, to be ultimately superseded by scientific cookery, by preparing vegetables in such a manner that they shall be as easily digested as the prepared grass we call beef and mutton. I do not mean by this that the vegetable we should use shall be grass itself, or that grass should be one of the vegetables. We must, for our requirement, select vegetables that contain as much nutriment in a given bulk as our present mixed diet, but in doing so we encounter the serious difficulty of finding that the readily soluble cell-wall or main bulk of animal food—the gelatine—is replaced in the vegetable by the cellulose, or woody fiber, which is not only more difficult of solution, but is not nitrogenous—is only a compound of carbon, oxygen, and hydrogen.

XXIX.

Next to the enveloping tissue, the most abundant constituent of the vegetables we use as food is starch. Laundry associations may render the Latin name "*fecula*," or "*farina*," more agreeable when applied to food. We feed very largely on starch, and take it in a multitude of forms. Excluding water, it constitutes above three fourths of our "staff of life"; a still larger proportion of rice, which is the staff of Oriental life, and nearly the whole of arrowroot, sago, and tapioca, which may be described as composed of starch and water. Peas, beans, and every kind of seed and grain contain it in preponderating proportions; potatoes the same, and even those vegetables which we eat bodily, all contain within their cells considerable quantities of starch.

Take a small piece of dough, made in the usual manner by moistening wheat-flour, put it in a piece of muslin and work it with the fingers under water. The water becomes milky, and the milkiness is seen to be produced by minute granules that sink to the bottom when the agitation of the water ceases. These are starch-granules. They may be obtained by similar treatment of other kinds of flour. Viewed under a microscope they are seen to be ovoid particles with peculiar concentric markings that I must not tarry to describe. The form and size of these granules vary according to the plant from which they are derived, but the chemical composition is in all cases the same, excepting, perhaps, that the amount of water associated with the actual starch varies, producing some small differences of density or other physical variations.

Taking arrowroot as an example. To the chemist arrowroot is starch in as pure a form as can be found in nature, and he applies this description to all kinds of arrowroot ; but, looking at the "price current" in the "Grocer" of the current week (February 16th), I find, under the first item, which is "Arrowroot," the following : "Bermuda, per pound, 1*s.* to 2*s.*" ; "St. Vincent and Natal, $2\frac{1}{4}$*d.* to $8\frac{1}{2}$*d.*" ; and this is a fair example of the usual differences of price of this commodity. Nine farthings to ninety-six farthings is a wide range, and should express a wide difference of quality. I have on several occasions, at long intervals apart, obtained samples of the highest-priced Bermuda, and even "missionary" arrowroot, supposed to be perfect, brought home by immaculate missionaries themselves, and therefore worth three and sixpence per pound, and have compared this with the twopenny or threepenny "St. Vincent and Natal." I find that the only difference is that, on boiling in a given quantity of water, the Bermuda produces a somewhat stiffer jelly, the which additional tenacity is easily obtainable by using a little more twopenny (or I will say fourpenny, to allow a good profit on retailing) to the same quantity of water. Putting it commercially, the Natal, as retailed at fourpence per pound, and the Bermuda at its usual retail price of three shillings, I may safely say that nine ounces of Natal, costing twopence farthing, is equal to eight ounces of Bermuda, costing eighteenpence. Both are starch, and starch is neither more nor less than starch, unless it be that the best Bermuda at three shillings per pound is starch *plus* humbug.

The ultimate chemical composition of starch is the same as that of cellulose—carbon and the elements of water, and in the same proportions ; but the difference of chemical and physical properties indicates some difference in the arrangement of these elements. It would be quite out of place here to discuss the theories of molecular constitution which such differences have suggested, especially as they are all rather cloudy. The percentage is : Carbon, 44·4 ; oxygen, 49·4 ; and hydrogen, 6·2. The difference between starch and cellulose that most closely affects my present subject, that of digestibility, is considerable. The ordinary food-forms of starch, such as arrowroot, tapioca, rice, etc., are among the most easily digestible kinds of food, while cellulose is peculiarly difficult of digestion ; in its crude and compact forms, it is quite indigestible by human digestive apparatus.

Neither of them is capable of sustaining life alone ; they contain none of the nitrogenous material required for building-up muscle, nerve, and other animal tissue. They may be converted into fat, and may supply fuel for maintaining animal heat, and may supply some of the energies demanded for organic work.

Serious consequences have resulted from ignorance of this, as shown in the practice of feeding invalids on arrowroot. The popular notion that anything which thickens to a jelly when cooked must be proportionally nutritious is very fallacious, and many a victim has died of starvation by the reliance of nurses on this theory, and consequently feeding an emaciated invalid on mere starch in the form of arrowroot, etc. The selling of a fancy variety at ten times its proper value has greatly aided this delusion, so many believing that whatever is dear must be good. I remember when oysters were retailed in London at fourpence per dozen. They were not then supposed to be exceptionally nutritious and prescribed to invalids, as they have been lately, since their price has risen to threepence each.

The change which takes place in the cookery of starch may, I think, be described as simple hydration, or union with water; not that definite chemical combination that may be expressed in terms of chemical equivalents, but a sort of hydration of which we have so many other examples, where something unites with water in any quantity, the union being accompanied with an evolution of some amount of heat. Striking illustrations of this are presented on placing a piece of hydrated soda or potash in water, or mixing sulphuric acid, already combined chemically with an equivalent of water, with more water. Here we have aqueous adhesion and considerable evolution of heat, without the definitive quantitative chemical combination demanded by atomic theories.

In the experiment above described for separating the starch from wheat-flour, the starch thus liberated sinks to the bottom of the water, and remains there undissolved. The same occurs if arrowroot be thrown into water. This insolubility is not entirely due to the intervention of the envelope of the granules, as may be shown by crushing the granules *while dry*, and then dropping them into water. Such a mixture of starch and cold water remains unchanged for a long time—Miller says "an indefinite time."

When heated to a little above 140° Fahrenheit, an absorption of water takes place through the enveloping membrane of the granule, the grains swell up, and the mixture becomes pasty or viscous. If this paste be largely diluted with water, the swollen granules still remain as separate bodies, and slowly sink, though a considerable exosmosis of the true starch has occurred, as shown by the thickening of the water. It appears that in their original state the enveloping membrane is much folded, the folds probably forming the curious marking of concentric rings, which constitutes the characteristic microscopic structure of starch-granules, and that, when cooked at the temperature named, the very delicate membrane becomes fully distended by the increased bulk of the hydrated and diluted starch.

A very little mechanical violence, mere stirring, now breaks up these distended granules, and we obtain the starch-paste so well known to the laundress, and to all who have seen cooked arrowroot. If this paste be dried by evaporation, it does not regain its former insolubility, but readily dissolves in hot or cold water. This is what I should describe as cooked starch.

Starch may be roasted as well as boiled, but with very different effects. The changes that then occur are much more decided, and very interesting. I will describe them in my next.—*Knowledge.*

HOW FLIES HANG ON.

BY DR. J. E. ROMBOUTS.

IT was believed at one time that flies and some other insects owe the faculty of running over smooth bodies like glass to the numerous hairs with which their feet are provided catching in the pores of the material. The absurdity of this supposition is readily apparent on examining glass with the microscope; and no naturalist can be found in these days to uphold it. Another theory, which has been frequently advanced, explains the fact by affirming that the feet terminate in little suckers, by the application of which to the smooth surface the insect is able to adhere by the force of the pressure of the air, in the same manner that the street-boy fastens his leather sucker tightly to the flagging. Blackwall's investigations have demonstrated that such a contact as is here supposed does not take place. He has seen flies running over the inner sides of the bell-glass receiver of an air-pump from which the air had been exhausted. If we examine the foot of a fly through the microscope, we shall find that there are no suckers on it, but that the foot-cushions are furnished with very fine hairs that prevent all close contact with the glass. The theory in question which invokes the pressure of the air was first broached by Dr. Derham, and was accepted by most of his contemporary entomologists. Other observers, among them Dr. Hooke, were of the opinion that the insects were able to attach themselves to the glass by virtue of some sticky matter in or on the hair. Blackwall explained the fact by saying that a viscous substance flowed from each hair; and probably the majority of the later entomologists have accepted this explanation. In answer to it, we may say that, if there really were a flow of a viscous fluid from the hairs, the flies would not be able to move after they had rested in one spot for a little while, for the liquid would have dried or hardened so as to detain them; but we know that the insect can always fly away instantaneously, even if it has remained in the same place for hours without moving.

I have concluded from my experiments that it is not the pressure of the air nor the power of an adhesive liquid that gives flies the faculty of running over smooth bodies, but that the power should be attributed to the molecular action between solid and liquid bodies; or, in other words, to capillary adhesion.

If we examine the under part of the *pulvilli* (Fig. 1) with a microscope, we shall see distinctly that it is furnished with numerous hairs, regularly distributed. These hairs terminate, at their lower end, in a

Fig. 1.—Under Part of a Fly's Foot.—1. Pulvilli, 200 times. 2. Hairs found on the sides, 670 times. 3. Different forms of hairs.

kind of bulb, the form of which varies, whence flows an oily liquid that dries slowly and does not harden for a long time. The minute drops left on the glass by the hairs may be taken away, even after two or three days have passed, without our having to moisten them, by simply rubbing a piece of fine paper over them. I have devised an apparatus for collecting these drops by cutting a hole in a piece of board over which I fix a glass slide. Turning the board over so that the glass shall be at the bottom, I have a little cell with a glass floor. With the aid of a piece of paper gummed to the wings, I introduce a fly into this cavity in such a manner that the pulvilli shall rest upon the floor. Then, putting the board under the microscope with the glass slide uppermost, we have the fly's feet under our eyes. The insect, struggling for liberty, places his pulvilli against the glass, and leaves after each effort, traces that may be observed very distinctly, for they are perfectly visible in a good light (Fig. 2).

We may discover, whenever the feet of the fly come again into contact with these tracks or minute drops, that they are composed of a very liquid substance, for they spread quite readily on the glass. We can not admit, as some naturalists assume, that the liquid can hold the club-shaped hair-ends by suction. If this were the case, the ends

Fig. 2.—Under Part of a Fly's Foot.—1. Pulvilli, 200 times. 2. Tracks left on the glass. 3. Form of the hairs.

would change shape during the suction, and would take the form of a disk. The fly puts its feet down and lifts them up with an incomparable facility that would not exist if the limb were really acted upon by the pressure of the air.

There is no evidence here of an adhesive substance; such a substance would harden after two or three days, and would dry or at least become viscous, like Venetian turpentine or sirup.

The power which we are investigating can be due only to capillary action; for the liquid and the hairs are the only parts that touch the polished surfaces. The idea occurred to me that the faculty arose from the attraction that each minute drop exercises upon the hair with which it is in contact; and I made several experiments to demonstrate the possibility of such an effect.

I suspended a hair from a pane of glass, by means of oil of olives. Sticking the cut end of the hair into the oil, I fixed the part, by means of the oil that adhered to it, to the glass, which I had previously washed with great care. I thus succeeded in suspending from the glass a hair 16 centimetres long, with a volume of liquid not exceeding its diameter. Replacing the oil of olives with water, I obtained the same result. The hair was 0·06 of a millimetre in diameter, and the weight suspended may be calculated to have been 0·00045 of a gramme. Repeating the experiment with horse-hairs, I found that a hair 7·5 centimetres in length remained suspended under the same conditions. The hair was 0·12 of a millimetre thick, consequently the weight adhering to the glass was 0·00085 of a gramme. A hog's bristle 0·18 of a millimetre in diameter was suspended, although, being 55 millimetres long, it represented a weight of 0·00132 of a gramme.

I also experimented with a hair ending in a bulb, which I formed by holding the hair to a flame. I fixed to the glass a hair 0·06 of a millimetre in diameter, terminating in a bulb 0·12 of a millimetre in diameter, and weighing 0·00085 of a gramme, or the same as the horse-hair previously used.

The results of these experiments added weight to my supposition that the liquid does not have to be viscous to enable the flies to stick. To gain an absolute conviction, I weighed a number of flies, and found their mean weight to be 0·045 of a gramme. I then ascertained the number of hairs on the lower part of the pulvilli, and the size of the extremities which they brought to bear upon the glass. It is not an exaggeration to put the number on each *pelote* at 800 or 1,000; this would give the fly a total of 10,000 or 12,000 hairs, by means of which, with the assistance of a minute drop of liquid, it could support itself on a solid body. It is proper to add, however, that a fly running on a window has only three or four of its feet on the glass at a time, and that therefore only half of its hairs, or 5,000 or 6,000 of them, are serving it at once. I repeated my experiments, to determine the weight hairs are capable of supporting when suspended in the manner I have described, and found again that a hair 0·06 of a millimetre in diameter will bear a weight of 0·00045 of a gramme; of 0·12 millimetre, 0·00085 of a gramme; and of 0·18 millimetre, 0·00132 of a gramme, when the air is in motion. Then, according to my calculations, a fly would be able to walk upon glass, even if it weighed 0·020 of a gramme more than it actually does. I tested this by pasting little papers on the wings of flies to increase their weight. They still kept themselves on the glass; but they walked upward with some difficulty when their weight was doubled.

I perceived in the course of my experiments that the flies, especially the weighted ones, ceased to adhere to the glass when it was moistened with the breath. Blackwall had essayed to explain this fact by assuming that the sticky substance by means of which he supposed they adhered mingled with the water, and was so much diluted by it as to cease to be effective. I found, by examination with the microscope, that this was not the case; no mixture or dilution took place, but rather a repulsion of the oily liquid by the water, and that that, or the contrary of what Blackwall assigned, was the reason adherence failed. Adherence likewise failed when the opposite side of the glass was moistened with ether, in consequence of the condensation of vapor occasioned by the evaporation of the ether.

Adherence also fails completely when the glass is covered with a thin wash of oil. And a fly which has been put upon a glass so covered, and is then transferred to a clean glass, will not be able to adhere to that till after some interval. An extremely thin coating of oil is enough to bring about a failure to adhere; even the rubbing of the finger on the glass is sufficient. The failure in this case is caused by the running together of the little drops of liquid on the hairs, by which the adhering surface is much reduced below the total surface presented by the little drops acting separately. Each foot then acts as a single hair, the diameter of which is equivalent to its own; and, even if its diameter were equivalent to a millimetre, the six feet bearing together upon the glass would not be competent to sustain the fly. For, according to the experiment with the horse-hair, a diame-

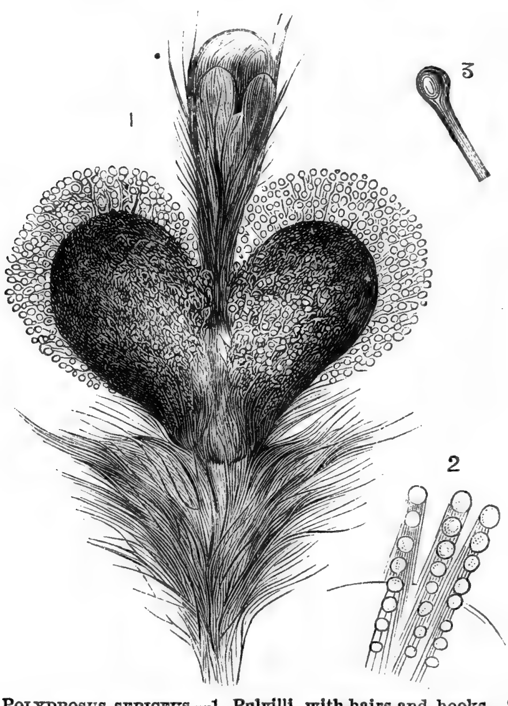

FIG. 3.—FOOT OF POLYDROSUS SERICEUS.—1. Pulvilli, with hairs and hooks. 2. Three hairs, considerably magnified. 3. A hair more considerably magnified.

ter of 0·12 of a millimetre will bear 0·00085 of a gramme; consequently, a diameter of a millimetre will bear 0·007 of a gramme, and the six feet together 0·042 of a gramme.

It is very difficult, if not impossible, for a fly to walk on a vertical polished surface when it is thinly covered with dust. When, after it has made the effort, we examine its feet with the microscope, we shall perceive that the interspaces between the hairs are filled with dust. After it has rubbed its feet against one another for a short time, and has passed its wings over them, the dust will be found to have disappeared, and it will again be able to walk on glass. The object of this labor, which flies may be observed to be performing at every moment, is not, then, as was once supposed, to cleanse the wings, but to keep the feet in good condition to stick on smooth surfaces. The wings are supplied with a kind of rough hairs that may very well fill the place of brushes.

Blackwall believed that flies cleansed their feet for the purpose of removing the superfluous viscous liquid from their pilæ. If this were the case, all the parts of the insect that touched its feet would shortly be covered with that substance; and, if it does not dry but becomes gelatinous, the fly would collect all the dust with which it comes in contact, and would soon look like a lump of dirt. Contrary to this, we know that flies are always clean.

Other insects that can walk on glass like flies have also, like them, little hairs with club-shaped terminations on the bottoms of their feet, and adhere in the same way. The accompanying illustration (Fig. 3) represents the end of the foot of a beetle (the *Polydrosus sericeus*), and shows that it is provided with all the appurtenances we have been describing.

I think I have proved by my experiments that the faculty possessed by flies of walking over polished bodies should not be attributed to a viscous liquid, but simply to capillary action. Even if this liquid, which causes the hairs to adhere to the polished surface, were nothing but pure water, the flies would be able to support themselves upon it, whatever position they might be in.—*Translated for the Popular Science Monthly from La Nature.*

WHERE DID LIFE BEGIN?*

By G. HILTON SCRIBNER.

THE subject of the distribution of plants and animals has for a long time engaged the attention of many able, persistent, and discriminating investigators. Much time and effort have been expended in simply observing and describing the various means by which they get about from place to place. The methods and means by which the seeds of plants are carried and deposited in new localities, the agency of insects, birds, and other animals in their distribution, no less than

* Preliminary portion of the author's monograph upon this subject published by Charles Scribner's Sons, New York.

their own ingenious contrivances for floating with the wind and tide, and for catching on to every moving object, all have been carefully observed and faithfully chronicled.

The first important truth enforced by these observations is that all organic life on the earth is, in a generic or tribal sense at least, migratory and nomadic. The individuals may be rooted and stationary, but the tribe is traveling, constantly leaving old fields and surroundings and as constantly arriving in new ones, sometimes crowded out, sometimes starved out, and sometimes invited out, but always moving —moving on to a new environment, better suited, taking all things into consideration, to satisfy the pressing needs of, and to develop and raise in the scale of being, both the individual and the species.

A second great truth taught by examining the methods of these movements and studying the causes of this ceaseless tramp of organic life is, that certain essential elements of the environment itself are usually found to be traveling with or a little in advance of the migratory species. In other words, the rainfall and isothermal lines, the climatic and other conditions of life, are constantly and slowly changing relative to the locality, but moving in fact. It has been frequently observed that certain species, occupying some particular territory now, have at some recent time in the past been enabled by such changes to crowd out other occupants of the same territory, and in turn will be undoubtedly, by similar changes and means, crowded out themselves. All kinds of plants and animals which have remained in one locality until they have lost the means of movement, which can not or will not travel, must sooner or later first degenerate and then be exterminated. For instance, a rain-belt or an area of dew-fall veers slowly but permanently from the north to the south ; an arid soil is made fertile, and a fertile soil is left arid ; the grass and flowering plants in endless variety move with the dew or the rain-belt ; the deer follow the grass, and the wolves follow the deer ; a thousand varieties of insects follow the flowering plants, and the insectivorous birds and other animals, herbivorous and carnivorous, bring up the rear, and so on, through all the interdependencies of life, the change of a single essential condition, the movement of one variety, causes a disturbance and movement of all in the neighborhood. Thence comes all this ceaseless and migratory activity among the flora and fauna of the earth.

This condition of things would indicate the possibility at least that life upon the earth had in the main commenced in some favored area, and traveled thence far and wide over the surface of the globe, driven out by changes of environment, lessening in effect the favorable conditions of its development in the place of its beginning, and ever beckoned on by more favorable conditions in adjacent districts. As there are no plants and no animals, with the exception of man, and possibly his companion the dog, and his pest the rat, that can thrive in most latitudes where any life is possible, so it is very evident that plants and animals, as we now see them, could not have made their advent upon the earth universally or simultaneously. Every geological fact contradicts both suppositions. Besides, to allege either is to claim, first, that all parts of the earth became habitable, for some form of life, at the same time, which is scarcely possible; and, secondly, such an allegation would do away with the main question of distribution, render superfluous most means of movement, and make it sheer nonsense to talk about the time, methods, and character of the distribution of that which had from the beginning been fully distributed. It is much more probable that life made its first advent upon this globe in some favored locality, and not everywhere at once.

It would seem as axiomatic a proposition as can be made in natural science, that life would make its first appearance on that part of the earth, or on that part of any developing planet, which by climatic and and all other concurrent conditions was first prepared, if not to originate, at least to receive and maintain it. Nothing can be more certain than that it could not make its first appearance on that part, or on any of those parts, wanting these conditions.

By concurrent conditions of climate or temperature, wherever the phrase is used herein, I mean such currents of air and ocean, such evaporation and condensation of water, such disintegration of rock, such electrical and chemical changes, new combinations, phenomena, and movements as are influenced by or accompany changing climate or temperature, together with all the secondary and remote effects caused thereby. And in speaking of the first appearance of life it matters not, to my mind, whether it was a creation, a development, or a transplantation; whether it was a lichen on the rock or a monad in the sea; a single solitary primordial cell, or one molecule of plasmic matter anywhere. This inquiry is not for the causes, methods, character, or extent of first life; it is simply and only concerning its probable *primus locus*.

If we are so fortunate as to discover where life began on the earth, it will be safe enough to rest upon the assumption that much, if not all, of the present life on the globe is its legitimate result and outcome.

I.

Are there, then, any data, any accepted facts touching the condition of our globe antecedent to the advent of plants and animals which would enable us to compare and contrast its past with its present condition, and which under known laws would indicate what portion of the earth's surface first became, by temperature, climate, and other concurrent conditions, habitable for life? Can any reasonable, probable, and still existing cause be discovered occurring in the very center of such first habitable portion which would have dispersed all vegetal and animal life and sent it in equal distribution through all the seas and over all the great continents as rapidly as such other portions of the earth became by temperature, climate, and other conditions ready to receive and maintain it? Is there any one locality answering to these conditions, and yet of which it may be said, in a grander and truer sense than it was said of Rome, that all roads lead to and from it; not only highways diverging to every part of the world, but with vehicles upon them; seed-wagons running constantly in the direction of the most favorable distribution and to the remotest parts of the earth? Any locality so related to the topography of the whole earth as to render such extensive movements of plants and animals from it in all conceivable directions, and to all distances, not only easy and probable, but consistent with their present distribution? Is there anything in similarity of form, anatomy, structure, size, color, food, habits, habitat, longevity, modes of propagation, terms of gestation, and capacity for inter-breeding between certain flora and fauna of the Eastern Continents and the Western, which would suggest that many species and varieties so widely separated might have come originally from the same locality and ancestry? Are plants and animals always improved, developed, and rendered prolific more by being moved one way than another? Are the prevailing bottom currents of air and ocean in the direction of such favorable movements? Are cases of extermination and degeneration the result of a counter-movement, or a failure to make such favorable movements?

Many facts and considerations exist and may be presented pointing to a solution of these questions, and fairly answering some of them.

Let us consider, in the first place, the probable condition of the earth previous to the advent of any sort of life upon its surface. A large portion of those who have formed any intelligent opinions, in the light of modern thought and investigation, upon the subject of cosmogony, believe and hold very firmly that the earth was at one time an intensely hot globe—indeed, a molten mass—and that in the lapse of time it has cooled down by radiation to its present temperature. It is not at all necessary for the purposes of the present inquiry to examine the so-called nebular theory, nor even to ask when or how this globe became so heated, nor to what extent it has now become cooled, nor need we inquire whether the earth is now but a molten mass covered with a comparatively thin crust, or has cooled and hardened to its very center. It is important, however, to have it understood at the outset that the facts and considerations here presented are addressed to those, and those only, who have reached and adopted the conclusion that this globe, at some time in the process of its formation and development, passed through a fiery ordeal, that the primary rocks are of igneous formation, and that there are many other existing conditions and obvious facts which can not well be accounted for except upon the hypothesis that the whole earth was once a molten mass.

Even after these admissions one embarrassment presents itself, happily, however, not affecting the argument, viz.:

So fully has every conceivable inference, every supposable fact and phenomenon in the development and history of the earth, been reviewed and discussed over and over again, in the light of this primitive glowing molten mass, by able and discriminating writers, that it may seem presumptuous at this late day to attempt any new deduction, or to draw any new conclusion radically important, touching this matter. But if the views here presented have been expressed before, in the relation of cause and effect, the writer has not been fortunate enough to meet with them, and it is quite safe to say that if they are correct their significance as a factor in other problems at least will not be questioned.

It is not claimed that these views have been proved to be true inductively, but there are certain facts and phenomena pointing directly to definite conclusions hereinafter stated which I am sure every one holding and believing that the earth was at one time a molten mass will find it easier and more reasonable to admit than to deny.

Regarding the earth, then, as at one time an intensely hot globe, totally destitute of organic life, one of the principal and indispensable conditions of rendering it habitable for plants and animals evidently would be the radiation into space of its excessive and destructive heat. The accomplishment of this, with the train of concurrent effects which would follow, or at least ever have followed the gradual reduction of temperature, is all that would be necessary to render the earth a suitable place for the maintenance of vegetal and animal life. At any rate this is precisely what has taken place since the commencement of the Azoic age, and is still taking place on parts of the earth's surface to-day, visible and obvious to any observer.

Our inquiry, therefore, is reduced to this question: What part or parts of the earth's surface first became sufficiently cooled by radiation to be habitable by plants and animals?

A supposed case may help us in reaching a correct answer to this question. Let us assume, then, that the earth, at the time it was a molten mass, had been and was revolving in an orbit so near the sun that the amount of heat it would have been receiving from the sun would have just equalized the amount of heat it was losing by radiation. Under these conditions it would have cooled as the sun cooled —neither faster nor slower. This helps us to understand that the heat received by the earth from the sun is, and ever has been, an offset, so far as it goes, to the heat lost from the earth by radiation. A statement of the loss of heat from the earth during any definite time may be formulated in this way: From the heat lost by the earth by radiation during a given period subtract the heat received by the earth from the sun during the same period, and the remainder will be the earth's net or actual loss of heat. Sidereal heat received by the earth being infinitesimal in comparison, is not here taken into the calculation. But, were it more considerable, it would not be important in this connection, for it falls upon all parts of the earth about equally.

It is evident, from the present condition of the earth's surface, that at the time it was a molten mass, and for a long time thereafter, it radiated heat into space much more rapidly than it received heat from the sun ; but nevertheless the heat of the sun is, and always has been, offsetting the loss of heat from the earth by radiation to the full extent of the heat which the earth had been receiving from the sun during the time.

But this sun-heat, this offset to radiation, has not been received by all parts of the earth equally. The equatorial belt, or torrid zone, has always received the most per square foot, or in proportion to its area. The two intermediate or temperate zones have received the next largest amount per square foot, or in proportion to their area ; while the polar or frigid zones have received the least per square foot, or in proportion to their area. If the amount of sun-heat received at the equator be rated at 1,000, then, upon the same basis, the average of sun-heat throughout the torrid zone should be rated at 975, the average sun-heat throughout the temperate zones at 757, and the average sun-heat throughout the frigid zones at 454, or less than one half that of the torrid and less than two thirds that of the temperate zones. We speak here, and shall hereafter, of the geographical zones of the earth for the sake of convenience.

The greatest amount of heat received from the sun and offsetting radiation from the earth, other things being equal, is, of course, as we have seen, at the equator, and less and less every degree north and south of this line to the poles. If, then, the frigid zones have been during all this time receiving the least heat from the sun—the least offset to their own loss of heat by radiation—does it not follow that they were the first parts of the earth sufficiently cooled to maintain vegetal and animal life? The inference seems inevitable.

CHRISTIAN AGNOSTICISM.

By the Rev. Canon CURTEIS.

THE title at the head of this article may appear to some a contradiction in terms. But it is not really so. And no religious man need shrink from saying : "I am a Christian agnostic. I hold firmly by the doctrine of St. Paul, who exclaims, in sheer despair of fathoming the unfathomable, 'O the depth of God! How unsearchable are his judgments, and inscrutable his ways!' I say, with Job and all the great prophets of the Old Testament, 'Canst thou by searching find out God?' And I bow to the authority of Christ, who tells me, 'No man hath seen God at any time'; 'God is a Spirit'; 'Blessed are they that have not seen and yet have believed.' And, in so holding, I am in full accord with the Church. I say with her, 'We know Thee now by faith'; 'The Father is incomprehensible (*im-mensus*)'; 'There is but one God, eternal, incorporeal, indivisible, beyond reach of suffering, infinite'—in short, a profound and inscrutable Being. Nor do I find that Catholic theology, for 1800 years, has ever swerved from a clear and outspoken confession of this agnosticism. So early as the second century, we read in Justin Martyr, 'Can a man know God, as he knows arithmetic or astronomy? Assuredly not.' * Irenæus, in the same century, repeatedly speaks of God as 'indefinable, incomprehensible, invisible.' † That bold thinker in the third century, Clement of Alexandria, declares (with Mr. Spencer) that the process of theology is, with regard to its doctrine of God, negative and agnostic, always 'setting forth what God is not, rather than what he is.' ‡ All the great fathers of the fourth century echo the same statement. St. Augustine is strong on the point. John of Damascus, the greatest theologian of the East, says bluntly, 'It is impossible for the lower nature to know the higher.' # Indeed, it would be a mere waste of time to adduce any more of the great Catholic theologians by name. They are all 'agnostics' to a man. And M. Emile Burnouf is quite right when he says, 'Les docteurs chrétiens sont unanimes à déclarer que leur dieu est caché et incompréhensible, qu'il est plein de mystères, qu'il est l'objet de la foi et non pas de la raison.'" ‖

Thus there is nothing new under the sun, not even in the highest flights of modern philosophy; and no man, with all the fathers of the Church at his back, need hesitate to say, "I am a Christian agnostic." Yet all who concur in this will, I am sure, warmly welcome a powerful auxiliary like Mr. Herbert Spencer, if only he remain true to the principles so lucidly set forth in the last number of this review ("Popular Science Monthly," January, 1884). For although he might not himself care to qualify his philosophy by the adjective "Christian," fearing thereby to limit—as a philosopher is bound not to do—his perfect freedom of speculation, still his guidance is none the less valuable to those who are approaching the same subject from a different side. The Christian, indeed, is, of all men, the most absolutely bound-over to be truthful. When, therefore, any great leader of thought arises, whether in the higher or the lower departments of human inquiry, the liegeman of a "God of truth" must needs feel such reverence as Dante expressed for Aristotle, "the great

* "Trypho," sec. 3. † iv, 34, 6, etc. ‡ "Strom.," v, 11.

\# "De fide," i, 12.

‖ "Science des Religions," p. 15. (Christian doctors are unanimous in declaring that their God is hidden and incomprehensible, that he is full of mystery, that he is the object of faith and not of reason.)

master of them that know"; and will borrow from the other twin luminary of the mediæval Church, St. Augustine, that most apt of all mottoes for a really "Catholic" philosopher, "The Christian claims as his Master's own possession every broken fragment of truth, wherever it may be found." In the firm conviction, then, that in Mr. Spencer's works much truth—not in detached fragments merely, but in large, coherent masses—is to be found, the present writer hopes to show how little there is to repudiate, how much to accept and to be sincerely grateful for, in his masterly speculations:

1. First of all, Mr. Spencer led us in his interesting article* to take a retrospective view of religion, in its origin and history. Naturally, he does not approach the question in the old-fashioned way. His purpose is not dogmatic, but analytic. That lovely *Haggada*, therefore, or religious story whereby, for babes and philosophers alike, the wonderful genius which constructed the Jewish Scriptures has projected, once for all, upon a plane surface (as it were) a picture of the origin of all things — this our man of science properly passes by; and he proceeds to inquire *how* precisely the beginnings of things, and especially of religion, may be conceived. And since, in these days, we have all of us "evolution" upon the brain, it was not to be expected that any other line of thought should be attempted. Indeed, it may be fairly conceded that, amid our modern scientific environment, no other method of inquiry is just at present possible. We belong to our own age. And while other ages have taken grand truths *en bloc* and have deftly hammered them out into finer shapes for practical use, the special delight and the crowning glory of our own age consist rather in a power of tracking things backward. Hence a hundred books of (so-called) "origins" issue annually from the press. Of course, no origin is ever really described, simply because there is no such thing in nature as "an origin." If there were, at that point all hunt upon the traces of evolution would abruptly come to an end; whereas, by the usual scientific hypothesis, evolution knows neither beginning nor end. By "origins," therefore, can only be meant arbitrary points a little way back, marked (as children or jockeys set up a starting-post) for commencing the inquiry. Indeed, it is very easy to imagine some imperturbable savage—say, a Zooloo of Natal or an English school-boy—asking the most reprehensible questions as to what happened before the "origin" began. Such a critic would be sure to express a languid wonder, for instance, as to *how* the primeval star-mist got there; or he would casually inquire *whence* the antediluvian thunder-bolt, which introduced vegetable life upon this globe, procured its vegetation; or he would ask *why* Mr. Spencer's aboriginal divine, roused from his post-prandial nightmare, should have selected a "ghost," out of the confused kaleidoscope of his dreams, as the recipient of divine honors. Nay, as was long ago suggested by a much

* "Religious Retrospect and Prospect," "Popular Science Monthly," January, 1884.

more serious thinker in reply to a similar theory: "To stop there is to see but the surface of things; for it still remains to ask how mankind have effected this transformation of a metaphor (or a dream) into a god, and what mysterious force has pushed them into making the transition. . . . In order to change any sensuous impression into a god, there must have previously existed the idea of a god."* Yes, clearly the latent idea must have been, in some way, already ingrained in human nature, so that it only needed (as Plato would say) an awakening from its hibernation; else why should human dreams produce a "religion" and bestial dreams produce none? The question, therefore, is not fully answered by Mr. Spencer's entertaining speculation, any more than the miracle (as Dr. Büchner all but calls it) of "hereditary gout" is explained by the jubilant pæan of the materialist, "Give me but matter and force, and all obscurities instantly vanish away!"† For no reasonable man, who accepts the modern doctrine of the eternity and identity of energy, can entertain a doubt that religion—the most powerful human stimulant we know of—must have pre-existed somehow in the bosom of the unknown, though it only revealed itself at a certain fitting stage in the development of the world. And when we have reached this confession, have we not simply found our way back to that general truth which the Church has couched in every sort of parable and symbol, viz., that (the "how" and the "when" being left for history to unravel) religious ideas, especially in their most fruitful and catholic form, are a gift, an unfolding, a revelation from the bosom of the unknown God?

2. There are, however, far more serious and more practical subjects for reflection suggested by Mr. Spencer's paper, than any which relate to the *past*. Let by-gones be by-gones! Our contemporaries are an impatient generation, and are very apt to consign to their mental waste-paper basket anything which they are pleased to condemn as "ancient history." What, then, has Mr. Spencer to tell us about the *present* state of religion? and what hopes does he unfold to us as we gaze, under his direction, into the *future?*

It is truly disappointing to be obliged to say of so devoted a student and so patient a thinker (1), that he has failed to work his subject out, and (2) that he has fallen into a passion.‡ It would be well worth while to make these two not unfriendly charges, if only they should succeed in inducing this able writer to give to the world some further product of his thinking on the strangely fascinating subject of religion. For the truth is that, when Mr. Bradlaugh and others proclaim, "I know not what you mean by God; I am without idea of God,"# they almost put themselves out of court at once by parading their inherent defect of sympathy with ordinary mental conditions. And when, in higher social grades, Dr. Congreve and the Positivists

* Burnouf, p. 29. † Büchner, "Vie et Lumière" (French translation), p. 315.
‡ "First Principles," p. 115. # "Plea for Atheism," p. 4.

openly "substitute Humanity for God,"* and refuse the transforming adoration of the heart to any conception which is not level to the bare positive understanding, they also—with all their eloquence and persuasive amiability—"charm" their contemporaries utterly in vain. As modern England will never again become papal and mediæval, so (it may be safely predicted) modern England will never become atheist or positivist. Our countrymen are in too healthy and vigorous a mental condition to impale themselves on either horn of this uncongenial dilemma. But they may, and it is to be hoped they will, surrender themselves to the far higher and more scientific teaching of men like Mr. Spencer; and will learn from them to think out to just and practical conclusions the deeply interesting—and to some minds the quite absorbing—question of religion.

But then—with all respect be it said—Mr. Spencer must really help us to think further on than he has yet done; or he will find the Christian clergy (whom he is under temptation to despise) will be beforehand with him. He has most ably "purified" for us our idea of God; he has pruned away all kinds of anthropomorphic accretions; he has dressed up and ridiculed afresh the Guy Fawkes crudities of by-gone times, which he apparently "sees no reason should ever be forgot"; he has reminded the country parsons of a good many scientific facts, which they read, it is true, in every book and review from Monday till Saturday and then so provokingly forget on Sundays; and he has schooled them into the reflection that a Power present in innumerable worlds hardly needs our flattery, or indeed any kind of service from us at all. But then all this is abundantly done already by the steady reading, from every lectern throughout the land, of those grand old prophets and apostles of the higher religious thought, who perpetually harp upon this same string. "God," they reiterate, "is not a man," that he should lie or repent; "Bring no more vain oblations"; "The sacrifices of God are a troubled spirit"; "Thou thoughtest wickedly that I am such a one as thyself"; "God dwelleth not in temples made with hands, neither is worshiped with men's hands, as though he needed anything." Nay, the present writer—who probably sits under a great many more sermons in the course of the year than Mr. Spencer does—is firmly persuaded that every curate in the Church of England and every Nonconformist minister are perfectly aware of these great truths and on suitable occasions preach them; and that what they want to be taught is something beyond all this A B C and all this negation—viz., what are the fundamental conceptions on which they may securely build up, not their philosophical *negations*, but their popular *assertions* about religion. For a religion of mere negations is as good as no religion at all. It seems hardly worth while to go down Sunday after Sunday to St. George's Hall, or to any other hall, simply to be told that Heaven has nothing whatever to say to us. We can

* "Positivist Prayer-book."

not believe that we are physically so well cared for as we are—naturally selected, evolved, provided with every possible adaptation to our material environment, and given the prize at last as "the fittest of all possible beings to survive"—and then are left utterly in the lurch as regards all our higher wants. No, our instinct revolts against such a supposition; and we crave to know on what grounds something can be *said*, as well as on what grounds almost everything can be *denied*.

3. Now, Mr. Spencer could help us in this quest, if he would. His analysis, in "First Principles," of our religious conceptions shows what he could do. He there—while carefully warning us that all our knowledge is merely relative, and that our reasoning faculties do not present to us truth as it is, but only as it is reflected on the mirror of our mind—places nevertheless such confidence in those faculties that he allows them, in Buddhist-fashion, to strip away feature after feature, as it were, from our religious conception of God, and to reduce it to a grim skeleton labeled "Everlasting Force." But why "Force" only? To begin with, surely this also is a "conception." It is engendered by a multitude of observations blending into a higher unity and taking at last a definite shape. And the only sanction it has to rest upon is, not (*ex hypothesi*) any certainty or absolute truth in human logic, but simply an ineradicable faith that, to us at any rate, the notions of "permanence" and "force" sufficiently *represent*, though they may not actually be, the truth. We seem, then, already to have made the grand transition from reasoning to conceiving, from destruction to construction, from restless analysis to quiet synthesis, and from logic to belief that the great Unknown is, in one word, Power—"an infinite and eternal energy."

4. But just as we draw from the stores of our own consciousness this idea of "Power," of force, of muscular or mental energy, precisely in the same way we are justified in drawing the idea of "purpose" in the direction of that energy. In fact, we can not anyhow conceive of force without "direction" of some kind; and our instincts imperatively demand of us, when we think of force in the highest and sublimest way we can, that we impregnate that idea with another product of our plastic imagination, and conceive it as efficiently directed to some worthy end—in short, as power and wisdom combined. This may be, and undoubtedly is, quite as human and relative and provisional a conception as that of a pure blind, unguided Force would be. But while the mind shrinks with unmitigated horror from the notion of "an infinite and eternal Energy," loose as it were in the universe, without any rational purpose or aim, but wielding portentous cosmic forces at hap-hazard, as a madman or a rogue-elephant might do, the mind rests and is satisfied when it can once feel assured that all is guided and has perfect efficiency for (what we can only call) some worthy "design." The word is, of course, utterly inadequate when things of such a scale are in question. But can Mr. Spencer or any one

else deny that, whatever sanction the human and relative conception of "power" draws from the inner certainties of our own sensations, that same, or a still higher, sanction can also be claimed for the conception of an infinite and eternal "Wisdom"? And if so, it appears that, if the agnostic lines which had reached the one conception were prolonged a little further, they would also reach the other; and that so the magnificent idea would be recovered for mankind of an Intelligent Being, with whom our infinitesimal yet kindred minds can enter into relations, and the wonder of whose works we can—as surely men of science above all others do—appreciate and assimilate as a kind of nutriment to ourselves.

5. But even then the imperative instinct which demanded the integration of Nature's observed forces into a conception of Infinite Power, and which was irresistibly borne on to add wisdom also to that Power—even then it is not pacified. It clamors for one more quality; and then it will be still. Relative, human, provisional—call it what you will—nevertheless this third and complementary conception will no more take a denial, will no more obey a frown and waive its right to rush into the inevitable combination, than matter will politely waive its chemical affinities. As the human mind is stupefied with terror at the bare idea of swift and gigantic energy abroad in the universe without purpose or intelligence (as we inadequately say) to guide it, so assuredly the human heart stands still in palsied horror at the frightful thought of "an infinite and eternal force," guided indeed by an infinite cunning, but checked by no sort of goodness, mercy, or love. In short, no authority on earth—not even that of all the philosophers and scientists and theologians that have ever lived—could impose upon any man, who thought Mr. Herbert Spencer's "First Principles" out to their ultimate conclusion, the portentous belief in an eternal, almighty, and omniscient DEVIL. And therefore to add *goodness* to the other two factors of *power* and *wisdom*, which we are compelled by the constitution of our nature to attribute to the Great Unknown, is pardonable because inevitable. But if so, it seems that agnosticism—if allowed to develop freely on its own lines, without artificial hindrance—must needs become a "Christian agnosticism." And it only remains to ask, why in the world should not such an agnostic "go to church," fall in with the religious symbolism in ordinary use, and contribute his moral aid to those who have taken service under the Christian name on purpose to purify gross and carnal eyes, till they become aware of the Great Unknown behind the veil, and so come to relatively know what absolutely passes knowledge?

6. There is only one obstacle in the way; and that is of so unworthy a character that it passes comprehension how men of cultivation can allow it a moment's influence upon their conduct. The objection referred to has never been more clearly expressed than by one whom we all delight to honor and to listen to, Professor Tyndall.

He wrote as follows in the pages of this Review a few years ago (November, 1878): "It is against the mythologic *scenery*, if I may use the term, rather than against the life and substance of religion, that Science enters her protest." But how, in the name of common sense and charity, is religion—that special provision for bringing strength to the feeble-minded, elevation to the lowly, and wisdom to the ignorant—to be brought home to all mankind, without the use of even coarse symbolism, which is as "relative" to the masses for whom it is intended as scientific conceptions are to philosophers? In both cases the realities behind are most imperfectly represented; and a higher intelligence, if it were not loving as well as intelligent, would certainly display impatience with Professor Tyndall's own kindly effort a few pages further on, where he says, "How are we to *figure* this molecular motion? Suppose the leaves to be shaken from a birch-tree; and, *to fix the idea,* suppose each leaf to repel and attract," and so on. Is it not clear that the Professor is here doing the very same thing, in order to bring science home (all honor to him!) to the unlearned, which he refuses to the ministers of religion when they try to bring home the Gospel to the poor? How can such subtile ideas, such far-reaching thoughts, as those of theology be brought home to the mass of mankind without the boldest use of symbol and of figured speech? How can that most precious result of Christianity, a unity of general conceptions about mankind and about the Great Unknown, be secured without a symbolism of the very broadest and most striking kind? Panoramas can not be painted with stippling-brushes. Nor, indeed, does any sort of painter aim to compete with the bald truthfulness of photography. He does not imitate—he merely hints. He throws out things *φωνᾶντα συνετοῖσιν.* He summons the imagination of the spectators themselves to his aid and awakens their finer susceptibilities. And by this means a "picture," which is in itself the most unreal of all unrealities, becomes in skillful hands a fruitful reality for good, perhaps, to a hundred generations.

If, then, any scientific man does not for himself need rituals and symbols, still let him remember how invaluable an aid these things are to the mass of mankind. Let him reflect how the purest and loftiest ideas of the Eternal lie enshrined within every form of Christian adoration, and how the most touching memories speak in every Christian sacrament. Is it nothing, too, to be brought in contact with the boundless gentleness and tolerance of Christ; to hear such words as "He that is able to receive it, let him receive it," and "He that is not against us is on our side"? Is it nothing to feel the sympathy of such a devoted benefactor of Europe as St. Paul, and to accept his judgment that "he who regardeth the day, regardeth it unto the Lord; and he that regardeth not the day, to the Lord he doth not regard it"? Nay, is it nothing to bow the knee in acknowledged brotherhood beside the simple and the lowly; to submit to learn from them, as we all learn from our children in the nursery; and to feel ourselves, in spite of our divergent views and notions, in the attitude of common adoration before the Great Unknown? Better this, surely, by far than to cover with philosophic scorn ministrants whose days are given to soothing every form of human distress, amid whose simplest teaching can always be detected in undertone the deep thoughts of Hebrew prophets and apostles, and to despise whom is to crown once more, with paper or with thorns, the meek head of CHRIST. —*Nineteenth Century.*

THE BEGINNINGS OF METALLURGY.

BY DR. E. REYER, OF VIENNA.

FROM recognized cosmical conditions, we conclude that the earth, like the other bodies in the universe, was originally a mass of vapor, which has undergone gradual cooling, condensation, and solidification. The heavier parts collected into a core, which, very likely resembling meteoric iron, was in the primeval epoch covered with glowing liquid masses of silicates, and the whole was surrounded by dense vapors. As the solidification proceeded, the ocean was deposited from the vaporous envelope, while the rarer atmosphere remained above. Both these elements are still mobile, and afford media for organic life.

The stratification of the rocks follows the existence of the ocean. The water dissolves matter out of the silicate crust and deposits it again. Thus have been and are still formed shales, sandstones, and limestones. The depositions have not, however, gone on without interruption; but the sedimentary beds have in all periods down to our own day been at times broken through by eruptions of the underlying silicates. Hence we meet so frequently in the various formations alternate masses of sedimentary and eruptive rocks. Both kinds have been used by men from the earliest times in tools and as building materials. On the one hand, stones have been employed in slabs and blocks in the construction of houses and walls, to mark graves, and for altars; on the other hand, smaller stones and flakes have been fashioned into instruments for beating and slinging; tough stones having weight have served as hammers, sharp chips of flint and obsidian for cutting and boring and piercing instruments. By the contrivance of these instruments man put himself in a condition to perform numerous operations. The ancient Egyptians, the Central-American races, and other civilized peoples certainly executed a large part of their works in stone with stone tools. Even the smoothing and polishing and the boring and sawing of stones do not necessarily require metallic tools, but were all formerly done with instruments of stone and wood.

It was believed a little while ago that the stone age was superseded by a bronze age. A closer examination of the subject has made it clear that we have in this case to deal not with sharply distinguished intervals, but with different degrees and conditions of civilization, which existed at the same time among different nations, and even among different classes of the same nation. Stone tools and weapons were still in use in Northern Europe long after the hard metals had become common in the South; but even in Southern Europe the poorer classes continued to use stone implements till late in historical times.

Survivals of stone-age civilization are now met with among only a few peoples; men have as a rule advanced to the metal-using stage, which has acquired its significance in consequence of the production of the hard metals. It is our purpose to review the origin, the acquisition, and the application of these important materials.

I have already spoken of the core of the earth as consisting chiefly of iron, while the crust is composed of eruptive silicates. The fluid from which these masses have been derived is a mixture of several combinations, the principal elements of which are oxygen, silicon, the lighter earth and alkali metals, and the heavier metal, iron. Oxygen predominates, and is combined with the other elements into stony oxides. The excess of oxygen floats around the oxidized dead-burned globe as life-air. I have mentioned only iron among the heavy metals important in civilization because it is the one that plays the most important part in the composition of the rocks. We also find smaller masses of other heavy metals in the primitive matter of the earth. Most of them appear sparsely distributed in the eruptive rocks in combination with sulphur, but a few occur in oxides. Besides these we also find ores concentrated in crevices and in pockets in rock-masses of different kinds, where they have been carried in aqueous solution. These local accumulations of ores first made it possible for men to obtain the rarer metals in masses and apply them to use. The metallic sulphurets nearer to the surface have been changed by atmospheric action partly into the simple metals, partly into oxides. This was a fact of great importance in the beginnings of metallurgic art; for the oxides are much easier to reduce to the condition of pure metal than the sulphurets. The unmixed metals—the precious metals and copper—are, of course, immediately available, and can be brought into any form that may be desired by hammering or casting. But little advantage was, however, derived from this circumstance. The first decisive step was not made till the hard metals, bronze and iron, were produced. These substances could not, however, be obtained at once, for neither the tin required for the manufacture of bronze nor iron in the metallic state was at hand; and it was a great step when the thought first occurred to man of separating the metallic elements from their stony ores. The myths of different nations generally indicate a god or a hero as the inventor of metallurgy; but it is now hardly doubtful that this god was in most cases a human mind directed by some accident.

Tin, iron, and the other metals, as we have said, do not occur pure, but as oxides in stone. They have a strong affinity for oxygen, and can not be separated from it and produced in a metallic condition, except by the aid of powerful reagents. There is one element which has a stronger affinity for oxygen than any metal—glowing charcoal, which, in the contest with the metallic oxide, wrests the oxygen from it. In the innumerable places where the primitive man—hunter, fisher, or nomad—built his fires, there can not have failed to be some where the red-hot coals would lie upon a soil containing ores. This would be sufficient to reveal the metallic treasure. By the occurrence of accidents of this kind, men learned to recognize the metal, and in a similar way how to extract it from the earth.

Of the two hard metals we have named, bronze came earlier into use, while the fabrication of iron belongs to a later period of civilization. It has been thought strange that bronze, a compound of two constituents, should have been got and used earlier than the simple metal, iron. And it has been objected that the former product is generally too soft to be valuable for weapons and tools, that pure copper is hard to get, and that tin-ore occurs in only a few places. All of these objections must yield to historical facts; and they can not be upheld against opposing geological considerations. First, it is not true that an alloy is harder to produce than a single metal. Man must in the beginning have melted up together the ores of different kinds as they occurred associated in nature, and thus have obtained a variety of alloys. Among others, copper and tin ores occur near each other in several regions. In such places bronze would have been produced, at first accidentally, afterward on purpose. In other places, where these metals are not naturally associated, one or the other of the constituents, or perhaps the alloy already formed, had to be imported. The second objection is no less fallacious: if substances containing phosphorus are melted up with the ores, the resultant product will have considerable hardness, which may be increased by repeated tempering and hammering. The third objection rests on observations in the most famous copper districts of Europe. It must be remembered in respect to the mines of these regions, that the operations have been carried on for a long time at a great depth, where the sulphurous copper-ores are, it is true, very hard to utilize. But in former times the ores lay nearer to the surface, and they were, in the degree that they were exposed, purified and made more reducible by atmospheric agencies. Oxides, carbonates, and pure copper were to be found. They were easy to smelt, and gave a pure product. It must also be remembered that tin was not so scarce in the earliest times as it is now; and there are still many places where it is not profitable to mine, that afford washings of tin of considerable richness. We thus see that the metal was useful, and that there was a sufficiency of rich, easily-worked ores. The conditions were, then, favorable for a long blossoming of the civilization of the bronze age.

The oldest historical information on this subject is furnished to us by the Egyptian inscriptions. From them we conclude that that highly civilized nation was in possession of metals from the beginning of its history. While the Indian Indra appears armed with the thunderbolt, "Akman" of meteoric stone, and the German god, Thor, carries his stone Mjölnir, the Egyptian gods are provided with metallic weapons; an evidence that the people were already acquainted with metals. Moreover, we find the spear designated after the name of a metal in the earliest inscriptions. As we say of weapons, "the sharp steel," as the Greeks and Romans described their weapons as of bronze and later of iron, so the Egyptians designated their lances by the name of bronze, and when describing bronze gave the sign for a metal, and explained it by the addition of that for a lance. Bronze was the prevailing metal. The metallic vessels, tools, and weapons of the ancient empire are represented in red, not in blue. It was the same essentially in the new empire, although the Egyptians had then become acquainted with articles of iron, and had obtained them by conquest and trade.

We meet this form of civilization again in reviewing the history of Mesopotamia and Syria. Babylon ruled over an alluvial plain, and was obliged to get all its metals from abroad by trade or conquest; Assyria possessed copper and iron within its own territory, but was dependent on other countries for tin. The countries whence this metal was obtained in antiquity were Midian, the Hindoo-Koosh, Farther India, and, at a later period, Spain and Britain; but the Phœnicians managed and controlled the trade in the indispensable mixed metal. Inasmuch as one of the essential metals was not found within the territories of the old nations of civilization, it will not do to ascribe the discovery of the manufacture of bronze to them. We must unquestionably look for the metallurgists of primeval times in other countries; and, in fact, traditions are not wanting to support such an assumption. The Hittites are mentioned by the Egyptians as the iron-workers of ancient times. The Mosaic books mention Tubal-Cain (a personified people) as the inventors and masters of metallurgy; and the Greeks designate, not the Phœnicians nor the Babylonians or Egyptians, but the Phrygians, as the ancient masters of art in bronze and iron, and praise the Chalybes of the Black Sea as distinguished steel-smiths.

Reviewing the facts we have so far adduced, we find that we have ascertained, first, that the ancient nations of civilization were predominantly in a bronze age; second, that they were dependent on other nations for the production of bronze; and, third, that peoples strange to them were practiced in iron-working at a period when they were still using only bronze. The metallurgy of the hard metals as a whole was thus originally not wrought out by the civilized peoples of whom we know the most, but by tribes who do not play so great a part in history ; by peoples who have not been perpetuated in fame by having founded great states, or by imperishable monuments or written records, but whose contribution to the world's advancement consists in the fact that, living in lands rich in metals, they discovered and developed the processes for working them.

I have sketched the metal-culture of the East as it represented itself to us at a time when the prehistoric stone age and a deep barbarism still almost exclusively prevailed in Europe. We now turn to the Indo-Germanic peoples, among whom we shall consider the Greeks in particular, and the other nations collectively. These peoples make their appearance late on the scene of history, and their myths play about a time when the Semito-Hamitic states had already left behind them the traces of a long civilization. We may, however, safely assume that many of the tribes had practiced metallurgy for three or four thousand years. We come to this conclusion from the fact that several of the peoples had the same names for the metals. They must therefore have been acquainted with metals and used them in their ancient common Asiatic home. This is confirmed by the Greek myths, which mention the Phrygians, who were settled in Asia Minor and on the adjoining islands, as the oldest metal-workers and the instructors of the Hellenes. They worked not only in bronze, but also in iron. The Indians also seem, at least just after the Buddhist reformation, to have been good iron-workers. Analogous conditions appear to have existed in Europe, where single peoples, at a relatively early period, even before the immigration, possessed metals, and when the remarkable fact meets us frequently that particular tribes (in contrariety to the mass of the ancient civilized peoples) obtained and worked iron.

We next consider the case of the Greeks, who are highly interesting to the historian of civilization not only by their great individuality but also by their multifarious relations with Eastern civilization. The original inhabitants of the country in which this important people settled appear to have been the Pelasgians, who may also be regarded as earlier immigrants of the Indo-European race. The Greeks probably learned the so-called Cyclopean architecture from them, but nothing supports the belief that they were influenced in metal-working by them. The Greeks obtained their start in those arts from the islanders and the Semites of the Asiatic coast through trade and colonization.

The most ancient settler in Greece is said to have been Cecrops, who came from Egypt in the second millennium before Christ. He founded Athens and gave laws to the people. From the same country came Danaus, who founded Argos. Pelops came from metal-rich Phrygia.

His sons conquered Mycenæ. A Semitic life also ruled in Orchomenos a few generations before the Trojan War. The city was wealthy, and the extensive plain was made tillable by an extensive system of aqueducts. Thebes, which was also founded by immigrants from the East, was the rival of this colony. The mythical hero Cadmus built the Cadmeian citadel and surrounded the city with the famous walls; he taught the nomadic people agriculture and the Phœnician writing, opened mines, and constructed aqueducts. The colony flourished rapidly, and accomplished the ruin of the formerly rich Orchomenos. Lastly, the myths tell of the doughty Sisyphus, who founded Corinth and established there the Semitic worship and Eastern civilization.

A lively activity went out from these and other colonists and colonies. Even the Semitic religion was partly accepted by the Greeks. The gloomy and repulsive service of Melkarth was always strange and abhorrent to them, but the worship of the fructifying Dionysus with its jolly festivals was warmly received. It entered into the life of the Hellenes and became national not only in the strongly Semitic islands, but everywhere on the Grecian mainland. The lascivious, mystic worship of the Semitic goddess of love, although humanized and beautified, was also one of the peculiarities of the Grecian people.

Notwithstanding this many-sided and powerful Semitic influence, which lasted for several centuries, the striving for national independence was strong even in the time of the earlier myths. Theseus, about a hundred years before the Trojan War, freed Athens from the island-chief Minos, to whom the state was then tributary. The Argonauts went out from Orchomenos and sought the distant metal-bearing land of Aja. The sons of the Argonauts besieged Troy, where they obtained treasures, the multitude and splendor of which astonished them. These were the first efforts of the Greeks to try their strength with the higher civilized Asiatics.

The great dispersion of the Grecian tribes took place in the succeeding times. The vigorous people spread on every side, and developed an unprecedented colonial activity. In the tenth and ninth centuries it settled numerous islands, and established a constant connection with the Asiatic mainland. The Milesians founded in the Pontus in the eighth century the city of Sinope, where they traded in iron and slaves, and Trapezium flourished in the ore-bearing country of the Chalybes. Syracuse, the metropolis of Italian Greece, was founded, and the colonization of Agrigentum from Rhodes followed. In the seventh century rose the cities of Selinus, Sybaris, and Croton. While the Corinthians were spreading out in the Mediterranean, the dominions of the Milesians were growing up on the Black Sea. In the sixth century, they had more than seventy colonies in those regions, and the productions of Colchis, of the Caucasus, and Armenia, of the Ural and the Danubian countries were flowing to them.

The ancient Oriental civilization, however, still long kept a prominent position by the side of these flourishing marts. Its influence on the development of Greece and of all the European peoples was deep and significant. As Roman civilization exercised a creative and shaping work long after the Germans had broken the power of the southern people, so also did Semitic civilization continue prominent among the Hellenic peoples long after the emancipation of the Greeks.

If we take the progress of the Greeks in metal-working especially into view, it reveals its dependence upon the Orient. According to their traditions, the Greeks received the processes of preparation and the applications of the metals from the Phrygians, but learned the higher technics of metal-work from the Phœnicians. Intercourse with the latter people also introduced the Oriental art forms to the West. All the productions of the earlier Grecian art bear an Oriental stamp; Mynias, who reigned in Orchomenos a generation before the Trojan War, was celebrated for his treasures of metals. He had an arched treasure-house, the walls of which were covered, after the Assyrian-Phœnician fashion, with plates of metal. He held intercourse with the Phœnicians, from whom he learned the art of building canals and irrigation. The treasury of Atreus, at Mycenæ, was likewise covered with metallic plates. Ulysses remarked the same style of ornamentation in the palace of Alcinous, where the walls were covered with plates of copper and the cornice was made of iron. In all of these cases we are informed from descriptions and from the latest excavations concerning the measure of Oriental influence in ancient Greece.

The useful metal in those times was almost exclusively the brown "chalkos." Of it consisted alike the finer wares which the Phœnicians introduced and the common fabrics which were imported from the neighboring islands, or were already made at home. It is significant of that early time that the smith was bluntly called "chalkeus"—copperer, or bronze-smith. The material, especially the home-made bronze, may not, it is true, have been of the best. The lances would bend, and the swords would break off at the handle. The better kinds of weapons, at least in Homer's time, seem to have been designated as "foreign," or as the gift of the gods. But after the dispersion of the Grecian tribes, following this period, a domestic industry of a better kind sprang up. The mines of Eubœa were exploited; the copper-smiths of Delos furnished metallic chairs and beds; from Ægina came all kinds of bronze vessels, and thence originated also the first stamped money. Most important of all was the development of statue-casting, which was introduced in the fiftieth Olympiad, and quickly reached a high perfection. The Spartans had already in a former age built their temple of Minerva with its bronze reliefs, rich in figures. At a later period, every city had its statues of metal, and some cities, during the time of their vigor, had thousands of them.

While thus bronze served at first quite generally, afterward predominantly for artistic purposes, iron in the course of time came to the front as the useful metal. We have already mentioned that the weapons of ancient times were almost exclusively made of bronze. I now say, besides, that the Greeks were acquainted with iron even in the mythological period. Whether any of the Grecian tribes worked in iron of itself is, however, doubtful. The blacksmiths of Crete and Lemnos are described as Phrygians ; and we know nothing more exact with reference to the origin of the Bœotians, who worked in iron in the most ancient times. We know, indeed, that they had trade relations with the Phœnicians, but this gives us no light respecting the iron art among them, for the Phœnicians of ancient times excelled only in bronze-working. It is also possible that they may have acquired some knowledge of metal-work in their Asiatic home. Whether this was the case, or the Bœotians learned to work in iron from the islanders, it is certain, first, that this primitive iron industry produced nothing of importance ; and, second, that although foreign weapons of steel were known and famous, bronze still prevailed for a long period as the metal of use. Homer, indeed, speaks of an iron that the country-people used in covering their plowshares ; he was likewise acquainted with the blue iron of which spear-heads were made, and with the tempering of steel ; and excellent weapons of iron are described in the Iliad ; but never, to my knowledge, is it mentioned that they knew how to make good steel weapons in Greece. The warriors were almost entirely armed with bronze, rarely with iron, and large articles of iron were very costly. It must not be concluded from this that small, simple vessels requiring neither a handsome shape nor a particular degree of hardness were not made out of native iron. In Homeric times, as I have said, plowshares were shod with a strip of iron of blacksmith's work. The iron reaping-hook came into use afterward. In Hesiod's time iron had gained the predominance over bronze among several tribes. I content myself with giving the history of metal-working in this single nation. With respect to the other European peoples we have a right to suppose that several of the tribes were acquainted with metallurgy in their original homes. They brought the knowledge of metals to Europe, which till then had been acquainted only with stone art. The greater number of the immigrants belonged to a lower grade of civilization, and the masses were still armed with weapons of stone ; but among them were a few individuals or families who brought some skill in metal-work from their Asiatic homes. In the course of time the people who lived near these metal-workers obtained metals from them, and the further diffusion of those materials was promoted by trade and war.

The most favorable situation was that of the dwellers on the southern sea, who enjoyed the opportunities afforded by the Phœnician trade. The ships of this people frequented the Black and Adriatic Seas, and the Spanish and Gallo-Britannic waters. Their goods were carried to the North by the inland routes. Foreign and domestic fabrics and shapes competed with each other over extensive districts ; iron came in contact with bronze, and both materials crowded upon the hard stone weapons of the earlier time. Steel had gained the predominance over bronze in all Southern Europe in the time of the Romans, and the last remains of stone-age civilization in that part of the world were extinguished in the early middle ages. Thus the same cycle of technical changes was completed in Europe as in the East. Still, considerable differences may be observed in the course of development in the two cases. The metal-working age begins much later in the West than in the East. Semitic civilization attained its highest development under the predominance of bronze, while the higher intellectual life of the Europeans is accompanied by that iron-working art which now rules over the whole earth. Roman iron mastered the East ; but it has gained immensely greater victories of peace in the Western world within a century through the agency of iron roads and wagons, swift steamers, and skillfully built and mighty engines.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

OUR NEW SKIN AND CANCER HOSPITAL.

By WILLIAM J. YOUMANS, M. D.

THE project recently initiated for establishing in New York on an adequate scale a hospital for the treatment of skin-diseases is of great importance to this community. It has been long understood that medical progress can only be best facilitated by the concentration of thought upon special groups of diseases, and that for this purpose special institutions are demanded. We have in New York four eye and ear hospitals, two for the ruptured and crippled, one for the throat, several for children's diseases, and the great Woman's Hospital known the world over for the advances in science made within its walls. But in regard to hospitals for the treatment of cutaneous affections we are not only behind the age and greatly deficient in this country, but in a condition of almost complete destitution. Something has been done in Philadelphia in this direction in a small way, but nowhere else until the beginning now made in this city. Students have been compelled to go abroad to find adequate facilities for the study of skin-diseases in the large hospitals of Paris, Vienna, Berlin, London, and other places ; although cases of diseases of the skin and cancer are very common in this country, very many occurring among us of the most severe, distressing, and often destructive character.

In regard to the relative frequency of these diseases in this city and country it may be stated that the number of persons thus afflicted is very large and appears to be increasing; at least 15,000 new cases of skin-disease occur in this city yearly among the poor, while there is no proper hospital accommodation for their care. In the matter of cancer the needs of the city are still more painfully evident. The malady is reported by the registrar-general to be on the increase in Great Britain, and the mortality from it has increased in New York of late years, according to the returns of the Board of Health, as may be seen from the following figures:

"In 1869 there were 304 deaths from cancer, being a little over *one* per hundred of deaths from all causes. In 1879 there were 572 deaths from cancer in this city, or a little over *two* per hundred of all deaths: that is, in ten years the proportion of deaths from cancer had nearly doubled, one death out of every fifty being from this dreadful disease. In 1880 there were 659 deaths from cancer, or 2·06 per cent of all deaths in this city; in this latter year cancer actually caused more deaths than scarlet fever, this being a very light year, with 618 deaths from this latter disease. In 1882 the mortality-tables showed 731 deaths from cancer in this city, or more than *two* daily. During these fourteen years 6,843 persons died of cancer in New York city. Patients suffering from cancer are welcomed in no hospital; in most institutions they are absolutely refused, and nowhere in this country are cancer cases grouped together with a view of studying the disease as to its nature and cure."

These painful facts show the urgency there was to take some serious steps toward the alleviation of this vast amount of suffering, and the New York Skin and Cancer Hospital has been established for this purpose. The institution was incorporated in 1882, and a dwelling-house was secured in 1883 at No. 243 East Thirty-fourth Street, where patients have been received and treated for the past year. The accommodations are, however, very limited, and so wholly insufficient that vigorous measures are now being taken for the extension of its operations until they shall become adequate to meet the public wants. Not only could but few patients be received, as the hospital now contains but twenty-nine beds, but serious difficulty has been encountered from the application of numerous cases of cancer for which the accommodations were wholly unsuitable. Some of these were in such advanced stages that their admission would have resulted in polluting the atmosphere to such a degree that the other beds could not be occupied. This experience has forced the managers to enter upon an enlarged plan of operations by which all patients, in whatever stage or condition of disease, may be taken for treatment without detriment to others.

A question may obviously arise as to the propriety of associating cancerous with skin diseases in the same institution; but the authorities of the hospital are well convinced that great advantages will ensue from this combination, and they have given the reasons for it in an instructive circular which we here reproduce with but slight abridgment:

Cancer, as popularly understood, does not represent a distinct disease, such as pneumonia, small-pox, or diphtheria, but the name suggests only some terrible malady of an eating or destructive nature, often, if not generally, terminating fatally after a period of great suffering. Among the medical profession the term cancer has been in time past, and to a certain extent is to-day, applied somewhat carelessly to a variety of diseases, or morbid conditions, presenting the feature of destruction of tissue to a greater or less extent; and even the highest science has not yet fully determined to what state or disease the name cancer should belong exclusively. Therefore, if a hospital were established exclusively for cancer it would be extremely difficult to determine just what cases should be received, and in the end but a small proportion of really proper cases would be cared for, if all but true cancer, as scientifically determined, were excluded.

This may be illustrated by supposing that a section of the city were taken, say from Thirty-fourth Street to Forty-second Street, and from river to river, and from every house all persons were gathered, who either—1. Supposed or feared that they had cancer; 2. Had been told by friends or by some quack doctor that they had cancer; or, 3. Had been informed by a legally licensed physician that they were afflicted with this disease. It would be perfectly safe to say that not one half, if indeed one third of all these persons would be the subjects of carcinoma, or real cancer, such as could be rightly entered under that name on the books of a hospital. The remainder of the large number would be afflicted with a great variety of affections, excluding, of course, some who were perfectly healthy, but with imaginary ailments. Of these others, who had not cancer, some would have very simple skin-diseases, entirely curable by proper treatment; many would have some of the ulcerating forms of syphilis, which are constantly mistaken for cancer, and which often so closely resemble it as to render the diagnosis most difficult, indeed impossible to one not fully acquainted with the former disease; some would have lupus, a skin affection which may also simulate cancer; besides these there are ulcers of various kinds, also rare diseases, such as sarcoma, rhinoscleroma, lipoma, morphœa, keloid, lymphangioma, and other diseases belonging to the department of dermatology, to say nothing of true leprosy which occasionally is presented for treatment. All of these could readily at times suggest the disease cancer to the patient or physician. Besides these there would be tumors of various kinds, abscesses, swellings of bones and many different conditions which the body or its parts may take on in disease, which would constantly be presented at the clinic of an institution for the cure of cancer.

The argument and suggestion are submitted, if one whose attention and thought are constantly devoted to the various diseases which appear on and beneath the skin, and which may at times very closely simulate cancer, if such a one is not more likely to recognize and treat the disease successfully than one who takes the single disease cancer for treatment without being acquainted with other apparently similar affections? If the dermatologist is not competent to care for cancer, under whose province does it specially fall? It must be remembered that there is nothing peculiar in the treatment of cancer, and that there is perhaps no regular physician in this country who can be said to stand distinctly pre-eminent in the knowledge of its nature and treatment: it is the quacks who are mainly known in connection with cancer.

Cancer is described and treated of in the books on diseases of the skin, and is constantly exhibited and lectured upon in the public clinics on diseases of the skin. In many instances cancer attacks the skin alone, and in many more instances it appears first on or just beneath the skin, and afterward affects other organs. The cases of skin-cancer, which are often terribly destructive, constantly fall under the care of the dermatologist, and are most frequently sent to him in consultation and for treatment by other physicians.

By the union of cancer with skin-diseases in the same institution, many persons may be led to seek relief long before the case would be recognized as cancer either by the patient or by many physicians; and thus the disease may often be arrested very early in its course, when wrong and harmful treatment or neglect may allow the disease to spread until it is too late to hope for any permanently good results from treatment. Of this many cases in proof could be cited.

Many individuals would be inclined to go to an institution which treats skin-diseases in conjunction with cancer, when they would be unwilling to admit that they had cancer; as a rule, the disease is kept secret as long as possible. There would also be less fear of a surgical operation connected with such an institution than in one specially devoted to cancer alone. It often happens that patients who are afflicted with true cancer refuse to have a surgical operation performed, either at all, or until, after long suffering, they are led to it as a last resort, when it is too late. Such patients will often submit to treatment by caustics, which in certain cases yield most excellent results. In skin-cancer the method by caustics is often to be preferred to operations by the knife, the results being rather more sure, and the scar often much less disfiguring. Such cases certainly are best cared for by the dermatologist, who daily has to do with applications soothing or caustic to the skin.

If the future offers any hope for the real cure or prevention of cancer, is it not in the way of careful and patiently conducted experiments with diet, drugs, etc.? Who is better fitted for the study of cancer as a disease than the dermatologist, who has devoted his attention to the study and management of the system as influenced by such constitutional conditions as gout, rheumatism and scrofula, and such poisons as malaria, leprosy and syphilis? The dermatologists, also, have been foremost in the study of pathology and microscopic anatomy, upon which our present knowledge of cancer largely rests.

The study of such a chronic disease as cancer, then, belongs very naturally to the dermatologist, who has continually to do with maladies often very destructive in character, which may last over months, and sometimes years, although, as in many other affections, he may require to call in the aid of others to accomplish certain ends; as, when the eye or throat is affected, or serious surgical or gynæcological operations are to be performed, etc.; the same may happen in the practice of any medical man.

The surgeon, who naturally inclines toward operative interference, is less likely to take an active interest in chronic cases and those unfit for operation than one who sees the complaint more broadly, and probably earlier, from its medical stand-point, and who seeks the aid of the surgeon only in suitable cases, as occurs also in private practice. In his endeavor to avoid the use of the knife he is the more inclined to search for the cause of cancer and the means of reaching it medically, and is thus more nearly on the right track toward prevention and cure than he who sees a case of cancer mainly from its operative aspect.

For the reasons here set forth, the New York Skin and Cancer Hospital was planned several years since, and nearly two years ago the foundation of the institution was laid by a few gentlemen, who signed the certificate of incorporation, April 8, 1882. After very considerable thought, and after conference with gentlemen well acquainted with hospital work, and with a number of prominent medical men, it was decided to organize the medical service upon this plan, and to have the main conduct of the institution devolve largely upon those who were well acquainted both with cancer in its various phases and with also the other affections with which it might be confounded.

But as it was recognized that many very serious operations have constantly to be performed in connection with this disease, it was determined to secure for the institution, and for the patients requiring aid, the very best surgical skill obtainable. Believing that those connected with other large hospitals, and in the habit of operating daily, could operate more skillfully and successfully than those whose experience was more limited, it was decided to add to the medical staff two operating surgeons, who should "perform such operations as are requested by the attending physicians, subject, however, to their own judgment and the advice of the consulting physicians and surgeons, if desired." In this manner, while the disease is studied and cared for medically, none need suffer for the lack of the best surgical aid when required.

It was also recognized that many operations upon women were better performed by those who were familiar with this branch of practice, and who were operating daily in their own special department. For this purpose a gynæcologist was added to the service, who should have charge of cases of internal cancer in females. Inasmuch as this class forms quite a large proportion of all the cases occurring in females, and the disease may at times prove very troublesome, a separate ward was set apart for the purpose, under the exclusive care of the gynæcologist, where special treatment could be more satisfactorily carried on.

To meet the further requirements of the hospital, a consulting board of physicians and surgeons was formed, containing gentlemen of prominence in various departments of medicine, in order that the best advice might be obtained in cases affecting the eye, ear, throat, etc., and in matters of general medical importance. A pathologist was also added to aid in the study of disease.

In the consideration of the subject of the association of cancer and skin-diseases in the same institution, it must be remembered that it is against common medical precedent to have a hospital devoted to a single disease, such as cancer. The tendency of specialism is to become too narrowed, to fix too much attention upon one single subject or portion of the body, to the exclusion of others which may and generally do have the utmost relative importance. When, from studying or practicing a special branch of medicine, one comes to confine the attention to a single disease, the danger is increased manifold. Those who have heretofore claimed to devoté their exclusive attention to cancer have been mainly found among the class of quacks who prey upon the credulity and ignorance of suffering humanity. Cancer, to be studied and treated scientifically, requires to be still kept where it belongs, one disease out of others of the same class. The London Cancer Hospital, the only one of its kind, as far as we know, would undoubtedly have been the means of much greater good if it had not been a special institution for a single disease, which from that cause has never had the hearty support of the British medical profession ; its usefulness might have been greatly increased had it either been attached to some other hospital (as, for instance, there is a cancer department attached to the Middlesex Hospital), or had it received at the same time the many cases of skin-disease which are often confounded with cancer.

If it be asked why the necessity of including the name cancer in the title of the hospital, it may be answered that only thus is *the full scope of the institution made known to the public*, and by this means multitudes of persons will be reached, who otherwise would never know that this disease was treated in the institution. As it appears by its recent annual report, the work at the hospital has been steady and useful ; it has been limited, however, by the capacity of the present building and by the limited means at hand for the work. With the establishment of the Country Branch Hospital, which has been contemplated from the first, and which will shortly be accomplished, which can be enlarged to any extent on the isolated pavilion plan, it is hoped and expected that the institution will soon devote much of its energies to cancer in all its forms and phases. The comparatively small number of persons with skin-diseases requiring treatment in bed may soon be greatly outnumbered by the cancer cases, but the institution will still remain a skin and cancer hospital, if the foregoing principles are correct, and if it is sought to do the greatest amount of good to the largest number of sufferers.

It being determined for these cogent reasons to adopt the plan of combining skin-diseases and cancerous affections in the same hospital, the problem arose as to the best method of carrying out the project, and for this purpose it was decided to establish a branch of the institution in the country adjacent to the city of New York. In his late address at the first annual meeting of the officers and friends of the hospital, Dr. L. Duncan Bulkley, the first of the medical officers, briefly reviews what has been done, and gives a very clear statement of the reasons that have induced the authorities to organize a country branch of the establishment. We give the main portions of his address:

"At this our first annual meeting, we find that the accommodations thus far secured are totally inadequate for the needs of the service; during the last few months our building has been quite as full as is desirable for health, while cases have been turned away which were unsuitable for our contracted quarters, and many male patients have been unable to gain admittance, all the beds devoted to this class being kept continually full. . . .

"The object of our thought this evening is, therefore, the means of extending the capacity and efficiency of our hospital, that it may approach somewhat to the size and requirements demanded by the large numbers of sufferers who call for our sympathy and aid. How can these ends be best attained? In which direction shall we enlarge, and how can we secure the greatest benefits to those who put their lives and their health in our hands?

"The tendency has been in all cities to build large and expensive structures, into which the greatest number possible of patients should be crowded, with the impression that thereby the best medical and surgical aid was afforded to the largest number of individuals.

"But the matter of bringing many patients together for treatment in one room and under a single roof has been studied from statistics by a number of competent and conscientious persons, and the results obtained are not a little startling when the mortality of such institutions is compared with that found among patients in private houses, and in cottage hospitals made to conform as nearly as possible to the conditions found in private houses.

"While the present magnificent building of the New York Hospital was being erected in Fifteenth Street, a committee of the governors of that hospital were engaged in making a report in regard to 'a village of cottage hospitals,' which was printed in 1876, and is a most careful and thorough study of the subject, from a scientific stand-point, and is most conclusive in favor of the country plan of treating patients. From this report, and also from the work on hospital construction and organization issued by the Johns Hopkins Hospital, I shall draw various of the facts and statements which I wish briefly to present.

"Careful study has demonstrated beyond peradventure that the nearer the condition of the patient approaches that of a member of a well-ordered household, the better are the chances of recovery; in small and separate hospitals the mortality diminishes with the size of the building, while in larger and more crowded hospitals the mortality is found to increase proportionately, and it reaches its height in those in which these conditions have existed for the longest time.

"In the report referred to is a quotation from Sir James Y. Simpson's essay on 'Hospitalism,' giving the following figures regarding mortality after amputations, which may be well considered in the present connection:

In large hospitals of Paris				. . .	62	per	100	die.
In British hospitals, with	300	to	600	beds,	41	"	"	"
" " " "	300	"	201	"	30	"	"	"
" " " "	200	"	101	"	23	"	"	"
" " " "	100	"	26	"	18	"	"	"
" " " "	25	beds or less,			14	"	"	"
In isolated rooms in country practice				.	11	"	"	"

In other isolated cottage hospitals in England during the year 1869, the mortality after operations was reduced to 6·7 per cent.

"In Bellevue Hospital there was at one time a mortality of forty-eight per cent after amputations, and at two of the public reception hospitals in New York the deaths in 1870, after amputations, were respectively sixty-five and sixty-two per cent. Other more recently built and better constructed hospitals show, of course, a very much smaller mortality, but the fact can not be gainsaid that large, substantial structures of brick and mortar, in a crowded city, do everywhere show a mortality much higher than that obtaining in locations where pure air, quiet, and sunlight can assist in man's endeavors to combat disease and injury. Spencer Wells, a prominent English surgeon, expressed the view that no surgical operation attended with risk to life should ever be performed in a great general hospital in a large town, except under such circumstances as would render removal to the country, or to a suburban cottage hospital, more dangerous.

"Much more could be added to show the advantages to be derived from securing a country location where a certain proportion of our cases could be sent, but time allows only a brief mention of important points in regard to the scheme actually proposed.

"Several locations have been under consideration for some time;

for, from the first inception of the hospital it was designed to have a country branch hospital where the more offensive and chronic cases could be provided for in a better manner and more cheaply than in a building in the city. From the statistics now at hand we learn that seven hundred and thirty-one persons died from cancer in New York city during 1882, that is at the rate of two daily: from this number it is probable that there are between two and three thousand cancer patients now in the city, and, as this is the only institution in the United States especially devoted to cancer, the numbers who would ultimately seek aid from this city, and from other portions of the country, would be very large.

"The idea, therefore, of a country hospital would be one composed entirely of pavilions containing a few patients each, so that the capacity of the hospital could be enlarged to almost any extent, as necessity required, while each pavilion, being of comparatively little cost, could be removed and destroyed whenever those terrible scourges of hospitals occurred in them, such as pyæmia, erysipelas, hospital gangrene, and other unknown causes of excessive mortality.

"In regard to the comparative cost of locating and running such a hospital, the showing is very greatly in its favor. Recently it was proposed to erect a wing or separate building in connection with the Woman's Hospital of this city, for the treatment of cancer, and the cost was to be about $140,000. This would give accommodations for not over eighty patients at the utmost, and could not be increased in size, however great the necessity; moreover, the objection would always exist in regard to the possibility or rather probability of the building becoming infected sooner or later with the poisonous germs of cases so loathsome as certain of those afflicted with cancer must become sooner or later. In addition, the mortality there must necessarily have been high, from the crowded locality, and from the presence of the noisy railroad.

"Now there is at present under consideration a tract of ground in a most desirable locality, containing nearly one hundred and fifty acres, with a number of valuable buildings upon it, which can be obtained for $50,000. Upon this twenty pavilions, each containing four beds, could be erected for $1,000 each, including furnishing. This would give accommodation for eighty patients at a cost of but $70,000, one half the cost of the proposed city building, leaving $70,000 of the amount for investment. Moreover, the country hospital could be extended to almost any size as occasion demanded, whereas, at the beginning there need be only a few pavilions erected, the number being increased as required.

"The cost of maintaining patients in such a place would be less than in the city, whereas the advantages arising to the patients would be incomparable.

"With fifty and more gentlemen and ladies thoroughly interested in our work, and with the support and encouragement of the medical profession and the press, no hesitation should be felt in pressing forward to such an extending of our usefulness as the importance of the subject seems to demand.

"Our president, Mr. Scribner, has been over the plot of ground under consideration, and can testify as to its suitability for the purpose.

"I would move that a committee of three gentlemen and three ladies be appointed to take the matter into consideration, and to visit this proposed site, if thought best, and to report on the subject to their respective boards."

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

SELF *VERSUS* OTHERS.

A MAN'S power of increasing happiness depends both directly and indirectly on his fitness for the occupations of his life. Directly, because if unfit, whether through ill health or inaptitude, he works with pain instead of pleasure, and because he gives less satisfaction or causes actual annoyance to those for whom his occupations, whatsoever they may be, are pursued. Indirectly, because as a result of work pursued under such conditions he suffers in temper and quality as a member of the body social. Hence all such care of self as is shown by attention to bodily health, by the careful culture of personal good qualities, by just apportionment of time to personal requirements, and so forth, may be regarded as of the nature of duty. In such degree as pleasure, recreation, change of scene, quiet, and the like, are necessary for the maintenance or improvement of the health, the care to secure these, so far from being held to be a concession to self, should be esteemed a most important point in "the whole duty of man."

A narrow view of duty to others may direct attention to what lies near at hand. Just as the savage consumes, to satisfy the hunger of a day, seed which should have been devoted to provide for many days in the future which lies beyond his ken, so the man who has no thought but of what lies near at hand, is apt to sacrifice health, strength, and fitness for work, from which great and long-lasting benefits might have been reaped, to obtain painfully and uncomfortably much smaller results. By overwork and self-sacrifice—self-devotion if you will—a man may in a few years effect much material good to those around him—perhaps more than in the time he could have effected by a wiser apportionment of his work and strength. But at the end of a much shorter period of work than he could have accomplished with ease and pleasantness, ere a tithe perhaps of the good he was really competent to do has been effected, his health breaks down, his strength fails him, he can no longer do the good he wanted so much to do. Nay, worse, life not only becomes a burden to him, but he becomes a burden to others. A wise and thoughtful care of self would have avoided this. Such care of self, then, even if regarded from the point of view which should be taken by the rest, is simply far-sighted regard for others.

Perhaps the simplest way of testing the matter is by considering what would happen if all or many of the members of a community followed a course which is commonly spoken of as if it were meritorious. It is manifest that a community chiefly composed of persons who neglecting self broke down their health and strength in exhausting efforts to advance the well-being of others would be a community constantly burdened by fresh accessions of worn-out and used-up members—including eventually most of those who had been most anxious to serve their fellows.

But the question becomes still more serious when the known facts of heredity are taken into account. The evil effects of self-neglect, whether in the form of overwork, or asceticism, or avoidance of all such pleasurable emotions as lighten the toils and worries of life, or in other ways, affect posterity as well as the individual life. Ill-health and weakness are transmitted to children and to children's children through many generations. It is not going too far to say that on the average more misery is wrought and to a much greater number by neglect of self than can be matched by any amount of benefit conferred during life, still less by such benefit as directly arises from self-sacrifice. A man shall work day after day beyond his strength for ten years, and by such excess of activity shall perhaps accumulate at the expense of a ruined constitution what may confer a certain amount of happiness on several persons, or keep discomfort from them. Probably with better-advised efforts during that time more real good might have been conferred on those same persons, for man does not live by bread alone; and certainly in the long run even of a single ordinary life much more good may be done by combining zeal for others with due regard for the welfare of self. But when we consider the multiplied misery inherited by the offspring of weak, sickly, and gloomy parents, we see that even though, on the whole, there had been during life a balance in favor of happiness conferred, this—more than outweighed even in the first generation—would be many hundred times outweighed in the long run.

CARE FOR SELF AS A DUTY.

The thought seems strange to many that in conduct which appears to them mere care of self there may be further-seeing regard for others than in simple self-sacrifice. Yet the matter is so obvious when pointed out as to suggest later a different sort of retort—namely, that it was scarce worth pointing out. Only, as it happens that this truly obvious matter has been grievously overlooked, as the teacher of this essentially true and therefore demonstrable lesson has been rebuked for inculcating mere self-seeking, it is tolerably clear that the lesson was very much needed.

Let us consider how obviously true it is, however, as he presents it. Take, for instance, the matter on which I touched in my last—viz., the consideration of the known laws of heredity. "When we remember," says the clear, calm teacher of our time, "how commonly it is remarked that high health and overflowing spirits render any lot in life tolerable, while chronic ailments make gloomy a life most favorably circumstanced, it becomes amazing that both the world at large and writers who make conduct their study should ignore the terrible evils which disregard of personal well-being inflicts on the unborn, and the incalculable good laid up for the unborn by attention to personal well-being. Of all bequests of parents to children the most valuable is a sound constitution. Though a man's body is not a property that can be inherited, yet his constitution may fitly be compared to an entailed estate; and, if he rightly understands his duty to posterity, he will see that he is bound to pass on that estate uninjured if not improved. To say this is to say that he must be egoistic to the extent of satisfying all those desires associated with the due performance of functions. Nay, it is to say more. It is to say that he must seek in due amounts the various pleasures which life offers. For beyond the effect these have in raising the tide of life and maintaining constitutional vigor, there is the effect they have in preserving and increasing a capacity for receiving enjoyment. Endowed with abundant energies and various tastes, some can get gratifications of many kinds on opportunities hourly occurring; while others are so inert, and so uninterested in things around, that they can not even take the trouble to amuse themselves. And, unless heredity be denied, the inference must be that due acceptance of the miscellaneous pleasures life offers conduces to the capacity for enjoyment in posterity; and that persistence in dull, monotonous life by parents diminishes the ability of their descendants to make the best of what gratifications fall to them."

All this is clear and obvious enough when thus pointed out; though the very passage in which Mr. Spencer here so clearly shows that to be happy, so far as by due regard of personal well-being one can make one's self happy, is a duty, has been selected for abuse as though he taught simply this—seek to gratify self in every available way. The kind of rebuke justly passed on those who in the search for pleasure, in mere self-gratification, ruin their health, lose happiness, become morose, gloomy, and misanthropic, lose taste for all pleasures lower as well as higher, and hand on to their children and their children's children these and other evil effects of the grosser forms of self-indulgence, has been passed upon the teacher of that far-seing care of self by which the health is preserved, happiness obtained, the whole nature strengthened and sweetened, the enjoyment of all forms of pleasure increased, and in all these respects the lot of posterity improved to many—nay, to uncounted generations.

On the other hand, there are those who, seeing that the doctrine taught is unassailable on that side, assert that it is and always has been obvious—forgetting how many morose and gloomy people there are who show by their mere existence that in the past (of which they are the descendants) the contrary doctrine has prevailed, as it still exists in the present (which they in part represent), and will continue doubtless for many generations.

If it be agreed that Mr. Spencer's teaching in this matter is needless where it is accepted and useless where it is needed (because none who would be benefited by it will listen), I answer that the case is otherwise. There are thousands now, and their number will be largely increased in the future, who have found in this teaching the lesson which they needed to make their lives happy and their influence in their own time and in the future blessed. It has come as a new and cheering light to them (I was going to say as a revelation, but the word would be misinterpreted) to see in happiness, their own included, the answer to the doleful question, Is life worth living? If by self-mortification, overwork, wear and worry, I make myself wretched and fail to make those around me happier, I may well ask in mournful accents that foolish question. If I not only fail so to make others happier but make them less happy, and hand on gloom and misery to future ages, I may not only ask it gloomily but answer it sadly, Life is *not* worth living. Better, were it lawful, to cease the painful and useless, the worse than useless, contest. But if by due care and thought of self, by reasonable enjoyment of the bright and pleasant things which life brings to most, I in some degree or wholly counterpoise such pains and sorrows as life brings to all, and at the same time help to brighten the lives of those around, and those also of generations as yet unborn, how shall I doubt what answer to give to the question, Is life worth living? Not sad is the answer, but bright and cheering.

There is still not a little to be said respecting the due care of personal well-being. Just here I close by remarking that, in the attempt to simplify Mr. Herbert Spencer's nomenclature, I certainly did not improve the title of this chapter by calling it "Self *versus* Others" as I did till now, instead of "Egoism *versus* Altruism," as he called the chapter in the "Data of Ethics" bearing on the same subject. Due care of self is not a matter of "self *versus* others," seeing that care of personal well-being is essential to the influence of self for the good of others. I have therefore given to this section a new sub-title.

But there is another aspect of this part of our subject which requires careful attention. We have already touched on the effects which would follow if all the members of society in their zeal for the interest of others disregarded the requirements of their own health and well-being, and overlooked the effects of unwise neglect of self on the interests of their descendants, and therefore of the society of which their descendants would form part. Nor, in considering this aspect of the subject, have we been dealing with imaginary evils, seeing that many of the defects of the body social at the present day can be clearly traced to such misdirected, though well-meaning, efforts on the part of the better sort in past ages.

But, when we consider the mixed nature of all communities, the mischief of ill-regulated disinterestedness as compared with far-seeing consideration of the interests of family, race, and nation, becomes more obviously a matter of practical moment.

If *all* men sought the good of others before their own, it is obvious that a confusion of interests would arise—other but not less unsatisfactory, perhaps, than that which exists in a society where, let their doctrines be what they may, the greater number seek their own welfare first. If, on the other hand, *all* men were moved by far-seeing considerations and a well-regulated care for the interests of others, no special care would be needed, and few rules would have to be laid down, to insure the progress and happiness of the community. But, as a matter of fact, neither one nor the other state of things exists. The body social as at present existing may be classified, as regards care for others and self-seeking, into the following principal divisions:

A. First, there are those who in precept, and as far as they can in practice also, think of others before themselves, who repay injuries by benefits, answer reviling by blessing, and adopt as their rule the principle that those who injure and hate them are those whom they should chiefly love and toward whose well-being their efforts should be chiefly directed. This class is very small; it is always losing members, but is probably increased by fresh accessions about as fast as it is diminished by those who leave it.

B. Secondly, there are those who, having for their chief aim the well-being of those around them and of mankind generally, yet recognize as necessary even for the advancement of that object, a due regard for the well-being—the health, strength, cheerfulness, and even the material prosperity—of self.* This class, like the first, is small; but steadily increases in every advancing community.

* One or two correspondents, whose letters have been handed to me, seem still unable to dissociate the idea of self-regard from the idea of selfishness, and imagine the man who duly cares for his own well-being (as the only effective way of fitting himself to be useful to others) to be necessarily one who really has at heart only his own comfort. It might be shown that the man who selfishly seeks his own comfort really goes the worst possible way to secure his own happiness. But, apart from this, such a man is not the man of whom I am speaking. I am inquiring what the man should do who really wishes to increase the happiness of those around him most effectively; and I show how his care for

C. Thirdly, come those who in all societies, at present, form far the greater part of the community—those, viz., who think chiefly of their own interests or their families', yet, though not specially careful to increase the happiness of others, are not selfishly intent on their own well-being only.

D. Fourthly, there are those who think solely of themselves, or, if they look beyond themselves, care only for their nearest kinsfolk, consciously disregarding the interests of others, and seeking only in the struggle for life the advancement of themselves or their families.

E. Lastly, there are those who, in their struggle to advance self, are prepared to prey on others if need be ; in other words, willfully to do mischief to others for their own advantage.

In this classification we consider only the actual conduct of the various orders, not their expressed opinions. Were these to be taken into account, the classification would remain nominally unchanged, but the numbers belonging to the different classes would be very much

their happiness involves, if he is wise, a due regard for his own happiness and well-being also—and even primarily, because his existence and his fitness to do good necessarily came before the good he may be able to do.

One correspondent asks whether a man who could save life at his own peril ought not, according to the views I have indicated, to consider whether his life might not be of greater value to the community than the life which he could save by sacrificing or endangering his own. I may remark in passing that the man who most freely acknowledged, as a matter of pure reasoning, that in such a case he ought to weigh his own life's worth against the worth of that other life would probably be the first to risk his life for others; while the man who made cheap parade of his readiness to sacrifice his life would probably be the readiest to slink away at the moment of danger. We are not considering, however, what men should do under sudden impulse of danger affecting others—and especially the weak and tender. If we were, we might point out that in such cases there is much more at issue than the mere value of the lives at stake. If I saw a child, weak-minded, crippled, of small worth as a member of the body social, in danger from which I could save it at the risk or even the certainty of losing my own life (which I might judge of more value to the community), I trust that, whether I had to act on impulse or after reflection, I should act, *not* as weighing the value of that life against my own, but rather as considering what would be the evil influence of cowardice and meanness in a community. If I had time to reason, I might reason that, whatever value my life might have, must go but a small way to counterbalance the effect of evil example.

In many cases, however, men are bound first to think of the value of their life: they do so even in cases where eventually they know that their life must be sacrificed. The captain of an endangered ship, for instance, cares for his own life more than for the life of any on board, *while* his skill and experience are necessary to save life ; and his actions in detail might under conceivable circumstances seem suggestive of mean care for his own life, when he knows at the very time that, after he has seen off the last boat—perhaps before many minutes are past—he and his best officers must go down with the ship.

It is singular and significant, however, that cavils such as I have here touched upon, come without a single exception in letters otherwise so worded as to show inexperience, deficiency of reasoning power, or that turn of mind, unfairly regarded as specially belonging to the weaker sex, which does not reason at all, but simply repeats parrot-like, and with constant reference to the last word, the maxims (often quite misunderstood) learned by rote in childhood altered. Most of the members of the body social in civilized, and especially in Christian countries, would be assigned in that case to Class A—though every one knows that in reality this class is a very small one indeed. Class B would be scarcely changed in number, because, while members of that class are ready to maintain that the views on which their conduct depends are, in their opinion, sound and just, these views are not such as the members of other classes are anxious to simulate. They are not popular views, like the self-sacrificing ones which so many pretend to hold, but by no means really act upon.

It is tolerably obvious that the well-being of society as a whole requires that Classes D and E shall not be unduly large, compared with the whole number of the community. Whatever tends to diminish their number, and especially the number of Class E, must tend to increase the well-being—that is, the happiness—of the social body. Class C, which always constitutes the main body, merges by insensible gradations into Class D, and Class D into Class E. Comparatively slight changes, influences relatively unimportant, suffice to transfer large numbers from the indifferent Class C to the self-seeking Class D, and similarly slight changes may suffice to transfer many from the simply self-seeking Class D to the noxious Class E. The lines of distinction between the first three classes are more marked. Members of the first class are more apt, at present, to pass into the third class than into the second, though little it should seem is needed to make these (the self-forgetting, enemy-loving members of the community) pass into the section combining due care of self with anxious desire to increase the happiness and well-being of the social body. That any members of the second class should pass either into the first, whence most of them came, or into the third, whose indifference to the welfare of others is unpleasing to them, or into the fourth, whose selfishness is abhorrent to them, is unlikely ; for which reason this class should logically have occupied the first place, seeing that the class we have set first really merges both into the second and into the third, which should, therefore, be set on different sides of it. We had a reason, however, which many will understand, for not depriving Class A of the position it holds theoretically, though practically the class has no such standing, and is especially contemned by Class C, the noisiest in pretending to accept its principles.

Since, then, the welfare of the body social depends mainly on the relative smallness of Classes D and E, the selfish and the noxious, it follows that an important, if not the chief, duty to society, for all who really and reasoningly desire the well-being and progress of the community, is so to regulate their conduct as to cause these classes to become relatively smaller and smaller. Conduct which can be shown to encourage the development of these classes, to make selfish ways pleasanter, and noxious ways safer, is injurious to the body social, and is therefore *wrong;* while, on the contrary, conduct which tends to increase relatively the number of those who are considerate of the welfare of others, is beneficial to the community, tends to increase the happiness of the greater number, and is therefore right. If, therefore, it can be shown that the principle adopted by Class A, however self-sacrificing, must tend to work far wider mischief in encouraging the development of selfishness and wrong-doing than it can possibly effect in the way of good (the good being local and casual, the evil systematic and wide-spread), then will it become clear that the principle adopted by Class B, which equally seeks the good of others, but entirely avoids the risk of encouraging the selfish and the evil-disposed, is that which can alone lead to permanent improvement and happiness in the social body.

This, as we shall next proceed to show, is unquestionably the case. —*Knowledge.*

WAS HE AN IDIOT?

By Rev. W. A. CRAM.

IN the quiet little town of Hampton Falls, New Hampshire, there has lately died a man whose life appears to the writer to present a psychological study of marked interest. Nature, in what are called her freaks, or abnormal products, oft-times gives us hints of powers altogether beyond the ordinary, but destined, it may be, through the development of the race, to become common possessions of mankind. This man furnishes a case in point.

The subject of our paper was about five feet six inches in height, when standing upright, but he stooped very much as he walked, his hands hanging far forward. His body was long, his legs very short, so that in walking he made the lifting, jerking movement in his step characteristic of quadrupeds trained to walk upright. His forehead, to the eye of a phrenologist, was very fully and finely developed. His occiput rose in a high point, but on each side there was a very deep depression. Phrenologically speaking, his head would have been considered well formed, save for these two depressions at the back.

His education, if so we may call it, was limited to learning the letters of the alphabet, so as to know them singly at sight, but he was unable to combine them into syllables or words. He could count as far as five or six, but beyond that became confused. He had a decided literary taste, judging from his interest in books and papers, in perusing which he spent much of his time, and apparently found much enjoyment. He did not hold the paper with column perpendicular, but horizontal, reading always from right to left. If any one gave him a book or paper, with page or column perpendicular, he at once shook his head, and placed it with the column horizontal. While perusing the paper, he would stop occasionally, lean back in his chair, and laugh, as if much amused at the matter. That he gathered some peculiar impression of what was in the paper is plain from the fact that he would be greatly interested in some part, and carefully lay the paper away till his sister came to visit them at the old home, when he would eagerly go and get it, and, poinitng to the part that had interested him, would say, "Read—read!" There was another peculiarity about his reading. He would begin to read when it was growing dark, and continue till hardly anything was distinguishable to others in the room. At first thought, one would naturally suppose that he could not see, or really read, but was simply indulging in some kind of idiotic amusement. One simple fact seems to negative such a conclusion. He kept old papers filed away in the garret, hundreds of them in different piles. If, by chance, an article happened to be spoken of by the family in conversation as having been in some paper six months or a year before, and the desire expressed to see it again, this man would go to the garret, and from a pile of a hundred, in total darkness, select the one containing the article mentioned, and bring it down to the family to read. This he did again and again, yet he could not read a single word as others commonly read.

The mathematical powers of this man were really wonderful in certain directions. Without a moment's seeming thought he would tell the dominical letter for any year past or future that might be named. There seemed no limit to his power in this one line. He appeared to go through no process of calculation, but at once saw or grasped the result as by some more inward or subtile power of apprehension. His brother again and again proved the correctness of his answers, although the mathematical result that the brother obtained by a half-hour's "figuring" this seeming idiot attained in a moment. Strangers coming to the house would oft-times tell him their age, the day and month of their birth. He would immediately tell them the day of the week they were born, also the day of the week their birthday would fall upon in any year to come. The day of the week that Christmas or fourth of July would come in any year they would mention, he would tell without a moment's apparent calculation, and yet he could not count, or reckon in the ordinary way, more than a child of three years old! His particular literary preference seemed to be for almanacs, often having three or four about him, which he apparently studied and compared. When it came near the end of the year, he was anxious and urgent to get the new year's almanac.

There was one peculiar performance that betokened a certain degree of musical taste and apprehension. He would sit for hours, with a board two or three feet long resting on his knees, and rub ribbon-blocks over it in various ways, producing different sounds, not altogether without method and with a kind of crude harmony. In this he found great enjoyment, often leaning back in his chair and laughing heartily at some unexpected combination of sounds. In the warm weather he employed a musical instrument of grand proportions, for he used the whole side of a long, old-fashioned barn, rubbing the blocks up and down as high as he could reach, the different boards giving forth somewhat different sounds as he rubbed his blocks over them. In a crude way he seemed to play upon the different boards, as an organist touches the different keys of his instrument. After years of this kind of musical performance, the boards on the side of the barn were worn quite thin.

He would never use or touch, if he could help it, any sharp-edged tool, being afraid of them as of some animal that might sting or bite. He was a hearty eater, and while eating would frequently stop and make the peculiar grunt characteristic of the hog while eating, then turning his head a little would seem to listen, and then go on eating.

Was this man a case of arrested development? Looked at in one way, he appeared so. The great length of the body, the short lower limbs, the forward stoop, the arms hanging far forward, the voracious eating, the frequent grunt, the animal-like turning of the head and listening while eating—all these things point to arrested development. On the other hand, the excessive development of certain other senses or faculties seems to show how, when certain unfolding powers and organs of the human being are suppressed, the life-forces shoot out and up enormously in other organs and senses; as in a young growing tree, if the top be broken off and most of the main branches lopped away, the sap flows more vigorously into the remaining branches, and they become enormously developed. Thus the common mathematical powers of counting and calculation appeared to be nearly aborted or suppressed, as he was unable to count or solve the simplest arithmetical problem in the common way; yet he solved in an instant mathematical problems that, by what we call our normal mental faculties, required several minutes of careful figuring to find a solution. Blinded and imprisoned where we commonly see and understand, had some of his faculties and powers surpassed the ordinary bounds in a higher and finer development? It appeared so. Was he an idiot? What meant his power of seeing in the dark, of selecting from among a file of hundreds a paper containing a particular article, published a year or more before, though he had never learned to read a sentence as we understand reading? May it not be that the printed page gives impressions of one kind to our common sight and understanding, and of another, finer kind to subtiler senses, and a different, may be a clearer understanding? Thus we trace a man's way by the tracks he makes in the snow or soft ground, while his dog follows him more surely, not by these so palpable signs, but by some finer track or impression, over or within what we see. May it not be that while we trace and apprehend the thoughts of the printed page, through the impression of the black lettering, this man received some finer impression from the printed page than any we know?

In closing this short account of a remarkable individual, we would only record one or two events prior to his birth, which afford some little explanation of what appears in this man as arrested development. His mother, not long before his birth, passed through a severe attack of measles. This at the time was not reckoned in the account of causes that might have unfavorably influenced the unborn child. One thing, however, was recognized as the probable cause of a pre-natal organic disturbance, viz., the fright of the mother by some hogs kept on the farm. Herein we have a possible explanation of those strange actions while eating, the peculiar grunt, the turning of the head, and the listening attitude, which are frequently observed when swine are feeding.

SKETCH OF MARY SOMERVILLE.

"WITHOUT forming what is ordinarily called an eventful career," says an English essayist,* "the life of Mrs. Somerville is marked by a degree of interest far beyond that which attaches to the lives of many men and women who have shown more striking traits of temperament and character. It is the unobtrusive record of what can be done by the steady culture of good natural powers, and the pursuit of a high standard of excellence, in order to win for a woman a distinguished place in the sphere habitually reserved to men, without parting with any of those characteristics of mind, or character, or demeanor, which have ever been taken to form the grace and glory of womanhood." "Nature" speaks of her as an illustrious woman, "unique, or almost unique, from one point of view, though so beautifully womanly from others." Sir Charles Lyell spoke of her, in one of his letters ("Life," Vol. I, page 373), as "the first of women, not of the blue."

Mrs. SOMERVILLE was born in Jedburgh, Roxburghshire, Scotland, December 26, 1780, and died at Sorrento, near Naples, November 29, 1872. Her father was Sir William George Fairfax, who commanded the admiral's ship in the battle of Camperdown, and was afterward made a vice-admiral. There was nothing congenial in the surroundings of her childhood to the scientific pursuits for which she even then seems to have had an inclination, and the influences under which she lived were rather adverse to the gratification of her tastes in that direction. Her earliest pictures of herself represent her as "a lonely child picking up shells along the shore, . . . or gathering wild-flow-

* "Saturday Review," January 10, 1874.

ers and gorse on the heath-clad links, . . . having neither dolls nor playmates." "When the tide was out," she says in her "Personal Recollections," "I spent hours on the sand, looking at the star-fish and sea-urchins, or watching the children digging for sand-eels, cockles, and the spouting razor-fish. I made a collection of shells, such as were cast ashore, some so small that they appeared like white specks in patches of black sand. There was a small pier on the sands for shipping limestone brought from the coal-mines inland. I was astonished to see the surface of these blocks of stone covered with beautiful impressions of what seemed to be leaves; how they got there I could not imagine, but I picked up the broken bits, and even large pieces, and brought them to my repository. I knew the eggs of many birds, and made a collection of them."

When ten years old, she was sent to school at Musselburgh, where she spent a year of misery. The chief thing she had to do at this expensive establishment was to learn by heart a page of Johnson's dictionary, not only to spell the words, give their parts of speech and meaning, but as an exercise of memory to remember their order of succession. Besides this, she had to learn the first principles of writing, and the rudiments of French and English grammar. From this place "she returned home, as she naïvely says, like a wild animal escaped from a cage, to revel once more in the curiosities of the sea-shore, sitting up half the night to watch the stars or the aurora, and having an instinctive horror, which clung to her through life, of being alone in the dark." Four or five years later she received her first introduction to mathematics, by one of the most curious accidents that could be imagined—through a fashion-magazine. At one of the tea-parties given by her mother's neighbors, she became acquainted with a Miss Ogilvie, who asked her to go and see fancy works she was engaged upon. "I went next day," Mrs. Somerville writes, "and after admiring her work, and being told how it was done, she showed me a monthly magazine with colored plates of ladies' dresses, charades, and puzzles. At the end of a page I read what appeared to me to be simply an arithmetical question; but in turning the page I was surprised to see strange-looking lines mixed with letters, chiefly X's and Y's, and asked, 'What is that?' 'Oh,' said Miss Ogilvie, 'it is a kind of arithmetic—they call it algebra; but I can tell you nothing about it.' And we talked about other things; but, on going home, I thought I would look if any of our books could tell me what was meant by algebra. In Robertson's 'Navigation,' I flattered myself that I had got precisely what I wanted; but I soon found that I was mistaken. I perceived, however, that astronomy did not consist in star-gazing, and, as I persevered in studying the book for a time, I certainly got a dim view of several subjects which were useful to me afterward. Unfortunately, not one of our acquaintances or relations knew anything of science or natural history; nor, had they done so, should I have had courage to ask any of them a question, for I should have been laughed at." She was afterward introduced to Nasmyth, the landscape-painter, under whom she practiced in copying pictures. One day she heard him say, in talking with some ladies about perspective: "You should study Euclid's 'Elements of Geometry'; the foundation, not only of perspective, but of astronomy and all mechanical science." "Here, in the most unexpected manner," she says, "I got the information I wanted, for I at once saw that it would help me to understand some parts of Robertson's 'Navigation'; but as to going to a bookseller and asking for Euclid, the thing was impossible." She afterward obtained, through a tutor in the family, a Euclid and a Bonnycastle's "Algebra," and studied—herself being her only teacher—her geometry by stealth, reading late in the night after she had gone to bed. The servants reported to her mother that she was consuming candles extravagantly, and orders were given to take away her candle as soon as she was in bed. She had, however, already gone through the first six books of Euclid, and was now thrown on her memory. She continued her geometrical exercises by beginning with the first book of her author and demonstrating a certain number of problems every night, till she could nearly go through the whole. She also studied Latin, reading six books of Cæsar's "Commentaries," and Greek enough to read Xenophon and part of Herodotus. While these things were going on, her father came home for a short time, and, learning what she was about, said to her mother: "We must put a stop to this, or we shall have Mary in a strait-jacket one of these days. There was X——, who went raving mad about the longitude." Her mother, though pleased with the acquisitions in music she made, was as unsympathetic as her father with her scholastic tastes; and, believing that women's duties were domestic, took great pains to divert her mind from her chosen "unladylike" pursuits, and keep her busied with household occupations. She received some sympathy from her uncle, the Rev. Dr. Somerville, afterward her father-in-law, who was one of the first to perceive her rare qualities; and from Professor Wallace, of the University of Edinburgh, who gave her a list of mathematical books, chiefly French. "I was thirty-three years of age," she writes, "when I bought this excellent little library. I could hardly believe that I possessed such a treasure when I looked back on the day that I first saw the mysterious word 'algebra,' and the long course of years in which I had persevered, almost without hope. It taught me never to despair. I had now the means, and pursued my studies with increased assiduity; concealment was no longer possible, nor was it attempted. I was considered eccentric and foolish, and my conduct was highly disapproved of by many, even by some members of my own family."

The future Mrs. Somerville had also gifts of another kind than her scholastic ones. She was admired for her good looks, and called "the Rose of Jedburgh"; and was conspicuous for her beauty, the youthfulness of her manner, and her light and graceful figure, to the end of her life. She was married in 1804 to Mr. Samuel Greig, Russian consular agent in London, who has been credited with encouraging her scientific tastes, but incorrectly. Her daughter, Martha Somerville, says that "Mr. Greig took no interest in science or literature, and possessed in full the prejudice against learned women which was common at that time." But he did not prevent her from studying. After three years of married life she returned, a widow, to her father's house in Burntisland, with two little boys, one of whom died in childhood. With her second husband, Dr. William Somerville, whom she married in 1812, "she found sympathy with her intellectual tastes, and a stimulus to her energy for culture." Nevertheless, his sister had written to her on the first announcement of the engagement, expressing the hope that now she would give up her foolish manner of life and studies, and make a respectable and useful wife. Dr. Somerville having been appointed Inspector of the Army Medical Board and Physician to Chelsea Hospital, they removed to London in 1816. Here Mrs. Somerville introduced herself to the scientific world and attracted attention by some experiments on the magnetic influence of the violet rays of the solar spectrum, the results of which were published in the "Philosophical Transactions" of 1826.

In the year following the reading of this paper, Lord Brougham proposed to Mrs. Somerville to write for the series of publications of the Society for the Diffusion of Useful Knowledge an epitome or popular exposition of Laplace's philosophy, as laid down in his "Mécanique Céleste." Acting upon this suggestion, she composed her "Celestial Mechanics," a work in which, though it is founded on Laplace's treatise, the author did not hesitate to express her own independent opinion of the value of the great astronomer's various propositions. The book proved to be too large and elaborate for the library for which it had been primarily intended—or, as Sir John Herschel expressed it, "written for posterity, and not for the class whom the society designed to instruct"—and was published separately, in 1831. It made her famous. The approval which it won, says "Nature" in a leading article, "from the first mathematicians and physicists of the day, seems to have surprised no one more thoroughly than the writer herself, who had carried on her studies with such unostentatious industry within her own home that she was scarcely conscious how exceptional were her attainments." On the recommendation of Professors Whewell and Peacock, the "Mechanism of the Heavens" was introduced upon the list of studies prescribed by the University of Cambridge as "essential to those students who aspire to the highest places in the examinations."

In 1834 she published "The Connection of the Physical Sciences," a work which was highly praised in the "Quarterly Review," was spoken of by Humboldt as "generally so exact and admirable a treatise," has passed through nine editions in English, and was translated into Italian and published in Florence in 1861. In the next year she was awarded by the Government a literary pension of £200, which was afterward increased to £300; and was made an honorary member of the Royal Astronomical Society, the second woman—Caroline Herschel being the first—on whom this honor was conferred. Her bust, by Chantrey, was placed, by a subscription of the Fellows, in the great hall of the Royal Society.

Mrs. Somerville's best-known work is her "Physical Geography," one of the earliest systematic treatises on that important subject, on which so much attention has since been bestowed, which was published in 1848. It has passed through several editions in England and the United States, has been translated into several foreign languages, and still holds a place as a first authority, even with experts, among the numerous learned works that have since been published on the subject. Of the publication of this book, Mrs. Somerville says: "I was preparing to print my 'Physical Geography' when 'Cosmos' appeared. I at once determined to put my manuscript in the fire, when Somerville said: 'Do not be rash; consult some of our friends—Herschel, for instance.' So I sent the MS. to Sir John Herschel, who advised me by all means to publish it." She afterward sent a copy of a later edition to Baron Humboldt, who wrote her a very kind letter in return, in which he spoke of the book as "that fine work, that has charmed and instructed me since it appeared for the first time. To the great superiority you possess, and which has so nobly illustrated your name in the high regions of mathematical analysis, you add, madame, a variety of information in all parts of physics and descriptive natural history. After the 'Mechanism of the Heavens,' the philosophical 'Connection of the Physical Sciences' has been the object of my profound admiration. . . . The author of the rash 'Cosmos' should, more than any other one, salute the 'Physical Geography' of Mary Somerville. . . . I do not know of a work on physical geography in any language that can compare with yours."

Her last work, "On Molecular and Microscopic Science," containing a summary of the most recent and abstruse investigations in that department, was published in 1869, when she was close upon her ninetieth year. This book was begun, she tells us in her "Recollections," about eight years before, when she was unoccupied, and felt the necessity of having something to do, desultory reading being insufficient to interest her; "and as I had always considered the section on chemistry the weakest part of the 'Connection of the Physical Sciences,' I resolved to write it anew. My daughters strongly opposed this, saying, 'Why not write a new book?' They were right; it would have been lost time; so I followed their advice, though it was a formidable undertaking at my age, considering that the general character of science had greatly changed." Instead of being discouraged by the magnitude of the field opened to her, "I seemed to have resumed the perseverance and energy of my youth, and began to write with courage, though I did not think I should live to finish even the sketch I had made, and which I intended to publish under the name of 'Molecular and Microscopic Science,' and assumed as my motto, '*Deus magnus in magnis, maximus in minimis*' ('God great in great things, greatest in the least'), from Saint Augustine."

This list of Mrs. Somerville's principal publications does not include all, nor even the most difficult of her works, for she produced, also, monographs on the "Analytical Attraction of Spheroids," "The Form and Rotation of the Earth," "The Tides of the Ocean and Atmosphere," "and, besides many others of equally abstruse nature, a treatise of two hundred and forty-six pages 'On Curves and Surfaces of the Higher Orders,' which she herself tells us she wrote *con amore*, to fill up her morning hours while spending her winter in Southern Italy."

With all these labors, and this concentration of her mind on the most difficult problems of physics and mathematics, Mrs. Somerville shone in the domestic circle, and enjoyed society and its amusements. "In reading the personal recollections of this wonderful woman," says "Nature," "nothing strikes one more than the ordinary and even commonplace conditions under which her great intellect advanced to maturity. In her case, the only exceptional features were her natural gifts, and her perseverance in cultivating them. Although 'the one woman of her time, and perhaps of all times,' so successfully did she conceal her learning under a delicate feminine exterior, a shy manner, and the practical qualities of an efficient mistress of a household, coupled with the graceful, artistic accomplishments of an elegant woman of the world, that ordinary visitors, who had sought her as a prodigy, came away disappointed that she looked and behaved like any other *materfamilias*, and talked just like other people." Mrs. Marcet wrote to her, announcing her election to a scientific society of Geneva: "You receive great honors, my dear friend, but that which you confer on our sex is still greater, for, with talents and acquirements of masculine magnitude, you unite the most sensitive and retiring modesty of the female sex; indeed, I know not any woman, perhaps I might say any human being, who would support so much applause without feeling the weakness of vanity." Miss Somerville says in the "Recollections": "It would be almost incredible were I to describe how much my mother contrived to do in the course of the day. When my sister and I were small children, although busily engaged in writing for the press, she used to teach us for three hours every morning, besides managing her house carefully, reading the newspapers (for she always was a keen and, I must add, a liberal politician), and the most important new books on all subjects, grave and gay. In addition to all this, she freely visited and received her friends. Gay and cheerful company was a pleasant relaxation after a hard day's work. My mother never introduced scientific or learned subjects into general conversation. When they were brought forward by others, she talked simply and naturally about them, without the slightest pretension to superior knowledge. Finally, to complete the list of her accomplishments, I must add that she was a remarkably neat and skillful needle-woman."

"At Edinburgh," says the English essayist in the "Saturday Review," "she had the opportunity of seeing Mrs. Siddons and John Kemble on the stage, and contracted a passion for Shakespeare. Poetry and works of the imagination had a charm to her from the first; and no girl more enjoyed dancing, or had more numerous partners at balls. At the same time, a degree of diffidence, mainly attributable to the seclusion of her early years, forbade her taking part in conversation, or speaking across the table. Through all her amusements, severe as the winter might be, she rose at daybreak, and, wrapped in a blanket, no fire being allowed, read algebra or the classics till breakfast-time. If tired in mind, as she was often conscious of becoming, in spite of her perseverance, refreshment was sought in poetry, or in stories of ghosts and witchcraft, of which she was constitutionally fond, being what the Scotch call *eerie* when in the dark or by herself, although having no actual belief in ghosts, and feeling a proper scorn for spirit-rappers." The practice of writing in bed, referred to in the preceding extract, appears to have been habitual with her, and "Chambers's Journal" gives a picture of her making it a rule "not to get up before twelve or one, although she began work at eight; reading, writing, and calculating hard—with her pet sparrow resting upon her arm—four or five hours every day, but these four or five hours were spent abed."

"The restless activity of her intellect," says "Nature," "never slumbered. When she received her first lessons in painting and music, she began at once to try and trace out the scientific principles on which these arts are based, and never rested till she had gained some knowledge of the laws of perspective and of the theory of color, and had learned to tune her own instruments." Another writer depicts the versatility of her life, and the abundance of the scientific friendships she contracted in association with her husband, who, "a traveler, a naturalist, a good classic, and a critical writer of English," was "one to share her studies and to be her support and companion in society and in travel. . . . Geology and mineralogy are among the first of their joint studies, and the extravagance of their cabinet of specimens is criticised. Acquaintance with the Herschels opens up practical astronomy. In London, Arago and Biot, who had heard of the English lady reading Laplace, express surprise at her youth. At Paris friendship is renewed with these *savants*, with whom are met Laplace himself, Arago, and Professor Humboldt; Cuvier does the honors of the Jardin des Plantes, and Gay-Lussac and Larrey entertain her with chat. . . . At Geneva she met Mrs. Marcet, whose 'Conversations on Chemistry' were said by Faraday to have first opened his mind to the wonders of that science. There, too, were Sismondi and De la Rive. A letter from De Candolle, whose acquaintance she had made there, gives shortly afterward some excellent hints for the prosecution of the botanical studies in which she had already made much progress. The interest which she takes in the most diverse branches of knowledge makes every one forward to bring her the first intelligence of anything new or of significance. Dr. Young is eager to submit an Egyptian horoscope he has that evening deciphered from a papyrus of the age of the Ptolemies; Wollaston hurries to Hanover Square to show, by means of a small prism in a darkened room, the seven dark lines he had discovered crossing the solar spectrum, the germ of the most important series of modern discoveries in solar physics; Babbage discourses over his analytical engine; Sir J. Herschel exhibits nebulæ and binary stars in the field of his great reflector; Ada, Byron's daughter, afterward Lady Lovelace, compares difficulties with Mary Somerville in mathematics. Among her most intimate and valued friends was Maria Edgeworth, to which number were later added Joanna Baillie and her sister. Year by year her acquaintance and correspondence grew, until they included well-nigh every name of distinction in literature or science."

This activity continued till the last day of her life. She spent many years in Italy, having removed there for the benefit of the health of her husband, who died at Florence in 1861 at the age of ninety-one, and continuing to reside there till her death. In her eighty-ninth year she revised some of her earlier mathematical manuscripts, which had been forgotten for many years, and was surprised at the facility she still retained for the calculus. One of her latest writings was the acknowledgment of the receipt from Mr. Spottiswoode of a parcel of recent advanced books upon the higher algebra, including quaternions. In her ninety-second year, when she had written of the "Blue Peter having long been flying at her foremast," and of her soon expecting the signal for sailing, she was interesting herself in the phenomena of volcanic eruptions, and speculating on their effects, and was following with unabated interest the progress of scientific discovery and keeping up with the record of events. She died in sleep. The list of scientific societies of which Mrs. Somerville was a member, and of honors she received, is a long one, and includes a number of American societies. She also had among her personal friends many men of chief distinction in American science and letters.

During her later years Mrs. Somerville noted down some recollections of her life, and they, edited and supplemented by her daughter, Martha Somerville, were published in 1873, under the title of "Personal Recollections, from Early Life to Old Age, of Mary Somerville."

CORRESPONDENCE.

A TYPICAL EXPERIENCE.

Messrs. Editors:

I AM one of your devoted readers, enjoy nearly all your articles, swallow nearly all of your latest theories, and try experiments suggested by the valuable chapters upon "Chemistry of Cookery."

Yesterday being the first pause in the deluge which we have endured for three weeks, I took advantage of the fair weather to make some calls, donned my better gown, and, alas! my best shoes, and paid twelve debts to society.

Returning at night, foot-sore and weary, I subsided into a wrapper, a pair of slippers, and an easy-chair, to enjoy a pleasant hour with the newly-arrived "Popular Science" for March, 1884.

In turning over the leaves, which happily are always cut, my aching feet caused me to read with eagerness the chapter on "Fashion and Deformity in the Feet," hoping to find some practical help for a life-long distress, the only consolation for which has heretofore been that I have not *four* feet to shoe, and the only hope for the future that I may one day become, with the addition of hands, like a cherub on a tombstone, a head and two wings.

I think no Chinese woman ever suffered much more from her poor little cramped toes than has your correspondent; so naturally I enjoyed Lord Palmerston's suggestion as to the treatment of shoemakers, shivered over all the interesting plates showing different fine specimens of deformed feet, rejoicing that my own pedal extremities were not so distorted, and read on with increasing hope that the person who understood the trouble so well would give a remedy.

Imagine my disappointment and chagrin after following the writer through all these charming and harrowing details to find this, and this only, at the end of the chapter: "We may hope for some not far-distant time when our demand will be for a normal, healthy foot, in a natural and comfortable covering, and not for a crippled and distorted, withered, ugly 'club,' bound in an instrument of torture"!

Now, this is exactly what I have hoped and striven for all my life, but how is a nineteenth-century woman to obtain the boon?

I have tried one shoemaker after another with like result. Each new one daintily lifts my old boot, pours contempt upon the shoemaker who made it, points out all its defects, and tells how much better he will do for me. I, with renewed hope, also denounce the old boot and the last shoemaker, and tell the new disciple of Crispin how much better work I expect from him. Measurements are taken; the new boots come home; I put them on and hobble round in agony. The shoemaker looks puzzled; alters the buttons; adds a lift to the outside of the heel; pockets my money, and after *that* answers my appeals with "They will be all right after you have 'broken them in.'"

I suppose it is all the fault of my feet that the shoes never do get broken in. The shoemaker is all right, the boots all that ought to be desired; but, in the first place, my feet are not rights and lefts, though they look like ordinary feet, and all my shoes must be "broken in" by wearing the left one on the right foot, and *vice versa*. Then, too, the skin is sensitive, and blisters easily; so I am doomed to hear fine concerts with two thoughts on my toes, trying to curl them into a more tolerable corner of my last "easy" shoes. The most eloquent sermon is heard with my toes twingeing quite as often as my conscience, while the supreme consciousness of being well dressed in company is undermined by the stronger consciousness of being altogether too well shod, and the most rapturous enjoyment of art or nature hindered by a very intrusive demand of the lower nature.

And now, in addition to the woes I know, comes the horrible fear of those I have just learned are possible. If, in addition to two little toes now not altogether like those of the Venus de' Medici, two or three corns and numerous blisters, my agonies are likely to culminate in such fearful extremities as are depicted from Figs. 5 to 10 in your late paper, and my poor feet are liable to be pictorially presented to the happier mortals of the future in some twentieth-century "Popular Science Monthly," to illustrate the barbarous customs of our own age, what shall I do?

It is so easy to say a woman should be independent of fashion, and consult health and comfort alone! How can one be independent of the shoemaker, unless she uses Indian moccasins, makes her own shoes, or goes barefooted?

Now, in common hu(*wo*)manity, after conjuring up these dreadful warnings and haunting pictures to terrify my already inflamed imagination, do tell us where and how to get comfortable coverings for our feet, and secure the everlasting gratitude of

A SUFFERING WOMAN.

PROVIDENCE, R. I., *February* 23, 1884.

A CURIOUS CASE OF ALBINISM.

Messrs. Editors:

There is recorded in one of the popular encyclopædias the instance of a Welsh family in which each alternate child was an albino. This is, without doubt, remarkable; but there is now living, in a rural village on the banks of the Hudson, the remnants of quite as interesting a family, composed of both colored and white negroes. The wonder is, that some one curious in research has not long since found them out, made them a study, and perhaps woven them into history.

Accustomed to see the members of this family daily, in my early life, they yet never ceased to be a new source of interest and astonishment; and, desiring to see them again, and to learn a few additional facts in regard to their history, I recently made a special journey to our native town—theirs and mine—expressly to meet them and talk with them once more.

The colored progenitors are still living, and are now probably between sixty and seventy years of age. Thirteen living children have been born to them, of whom five have been pure albinos, and eight just as pure representatives of the African type. The first birth was black, after which they regularly alternated, white and black, as far as the tenth, after which all were black.

According to the authorities upon this subject, albinos are usually males, yet four out of the five in this family have been females. The texture of the skin with this class is generally coarse and rough, but with these it has always seemed to me to be fine and delicate. The mental ability of albinos, as a class, ranks low, but it is not true in this instance—in fact, during my recent visit to them I was much impressed with their practical sense and quite correct use of language. In music the whole family, black and white, has evidenced native ability that is almost genius. A piano is one of the few household gods, and they have all been accustomed to play and sing from earliest childhood, without instruction, but very acceptably. Years ago, when the family was large, their clear, pure, though untrained voices awakened long echoes through the village streets, and even the most critical gossips found no fault with the melodious strains.

But three of the thirteen children are now living—one colored and two white daughters. The colored daughter has been married several years, and is the mother of a large family, none of whom, I am informed, bear abnormal traces. Both white daughters married colored husbands (their associations are, in fact, entirely with the colored people), and one is now a widow. She has been the mother of two black children, both of whom are dead. The other daughter has been married but a few months.

As children, playing harmoniously and affectionately together, the spectacle was very curious; I hardly know whether to term it one of pleasure or pain, but the abnormal and incongruous must, perhaps, always be productive of more or less painful emotions, even if there be no physical or mental suffering apparent in the object.

Those of the family that have died, whether black or white, faded young and with slight provocation; but the three now remaining appear healthy and strong.

As children, the albinos struggled with the sunlight, always placing both hands closely around the eyes, thus excluding every possible ray; but I observed, while with them recently, that they were far less sensitive to the light than formerly, and they so acknowledged. Because of their sensitive sight, Linnæus called this class of people nocturnals.

My purpose in this letter has merely been to call attention to this family, which has impressed me all my life as one of great interest. If any of my readers should desire further information, I shall very willingly, through the medium of this magazine, give names and address, or any facts in my own knowledge which have not been recorded in this communication. J. S. H.

Albany, New York, *March* 20, 1884.

INSECTS AND DISEASE.

Messrs. Editors:

In the January number of "The Popular Science Monthly" is a letter from A. G. Boardman, of Macon, Georgia, in which he describes the painful and mischievous results which follow when a "minute fly," called a "black gnat," flies into the eye and is killed by its secretions. He connects these consequences with the carrying of infection-germs by insects.

The true explanation of the intense pain and subsequent inflammation is, I believe, much simpler. Formic acid is a powerful irritant. It was originally obtained by pounding ants in a mortar, and distilling their remains. It is now produced much more easily, and has been shown to be secreted not only by ants but by other insects, and this secretion is apparently exaggerated when the insect is attacked or irritated. It is probably a means of defense. This being the case, such a fly, during its death-struggles amid the secretions of the eye, would emit a maximum amount of this irritant.

Cantharadin is another active irritant principle, emitted not only by the Spanish fly, from which it is named, but also by many other insects. Its irritant properties resemble those of formic acid, but are still more powerful; so much so, that $\frac{1}{100}$ of a grain applied to the outer skin of the body will produce a blister. On so sensitive a surface as that of the eye a very small fraction of this fraction would do serious mischief.

W. Mattieu Williams.

Stonebridge Park, Willesden, Middlesex, England.

GRAPES AS FOOD.

Messrs. Editors:

Dr. Oswald's article on "Enteric Disorders" (in your issue of December, 1883) recommends the grape-diet. Although the use of the grape is thus frequently extolled in general terms, I find that every individual has his own opinion as to how the fruit should be used. A doctor of standing has assured me that grape-skins were as indigestible as hard-boiled white of egg, and fit to be swallowed by no one. Again, I have heard it said that, when the system is in need of an astringent, the tannin in grape-skins answers that want; while the acid of the pulp and the mechanical irritation of the seeds act as mild laxatives. The inference was, that a healthy stomach should receive the whole fruit and keep its normal balance; as, however, the skin and seeds might be too irritating for a delicate stomach, the balance might still be kept by taking in pulp alone; further, that skin and pulp, or seeds and pulp, should be swallowed according as the system needed an astringent or a laxative diet. Others still would have the seeds as well as the skins rejected, under all circumstances. The same difference of opinion exists as to whether the skins of apples, raw and baked, as well as of plums, pears, and tough-skinned fruits in general, should be taken into a healthy stomach.

As Dr. Oswald has emphasized the dietetic value of the grape, it would be a satisfaction to know what, in detail, is his view of its proper use.

Respectfully yours,

Sarah U. C. Bolton.

Greenville, Plumas County, Cal., *February* 28, 1884.

EDITOR'S TABLE.

PROGRESS AND SOCIAL IMPROVEMENT.

THE contrasts in the social condition of rich and poor—the lofty, luminous mountains of wealth, and the deep, dark valleys of poverty—have ever formed a picturesque subject for rhetorical treatment, which has always made popular such books as "The Glory and the Shame of England." Mr. George's "Progress and Poverty" vividly pictures the social contrasts but ventures further, and opens the question of causes. He points to the millionaires, and their works, and their ostentation; to the beggars in their wretchedness, and says society is sick, very sick, and growing sicker every day; and, after sufficiently declaiming over its dangerous condition, he says, Here is the cause of the malady and this is the pill that will cure it. It had been supposed that social progress involved improvement, through many correlated agencies and by slow methods, but on this theory the sovereign use of Mr. George's pill was not so apparent. So, with a stroke at the close of his book, he smashed Darwin with his dawdling evolution, and thus cleared the way for his own prescription to cure the poverty and wretchedness of mankind.

Yet the rhetorician is not the man to deal with these subjects—except for literary or sensational purposes. A quite different order of mind is required to give us sound instruction upon them. First of all we must know the facts, not in a vague and general way, but accurately and in detail, and so classified that their real meanings are unmistakable. England, as we have intimated, is the country where social contrasts are most striking—where superabounding wealth is set off against the extremest destitution, poverty, and squalid wretchedness; and England, therefore, must afford the most terrible example of that alleged downward working of progress, which but continually aggravates the evils of poverty.

It was fitting, therefore, that a widely informed and thoroughly disciplined student of social facts, the President of the Statistical Society, Dr. Robert Giffen, should take up this subject carefully and systematically, and furnish us with trustworthy conclusions in regard to it. Dr. Giffen has prepared an elaborate essay on "The Progress of the Working-Classes in the last Half-Century," fragments of which have appeared in some newspapers, but which we now give to the readers of "The Popular Science Monthly" in full. It does not confirm the theories of Henry George, but, on the contrary, invalidates them. As Mr. Gladstone writes to Dr. Giffen: "I have read with great pleasure your masterly paper. It is probably in form and in substance the best reply to George."

Dr. Giffen goes exhaustively into the particulars of the social condition of the working-classes of England fifty years ago, and at the present time. He shows that wages have very greatly increased in that period, and he shows how much they have increased with different classes of laborers. He shows that accompanying this increase in the money-earnings of the masses there has been a marked diminution in the prices of all the chief articles which the masses consume. Moreover, while the money wages have increased, the hours of labor are diminished. And, while the purchasing power of money has been increased over the whole range of necessaries and conveniences to be had fifty years ago, there are many new things in existence at a low price which could not then have been bought at all. Free trade has cheapened wheat in England to such an extent as to revolutionize the domestic economy of the poorer classes. The fluctuations in the price of bread half a century ago and earlier led to periodic starvation; with free trade those fluctuations are greatly diminished, while the higher wages of laborers afford better protection against them. Meats generally, except bacon, have increased sensibly in price; but meat, fifty years ago, was a luxury to a great degree out of the reach of the laboring-classes. Rents are also higher, but the houses are much better; while the laborer, consuming meat, and with superior household accommodations, has still a large surplus from the rise of wages, as Dr. Giffen proves in detail. It is also shown that the cost of government has been greatly diminished to the working-man. Taxes are less, and local government is cheaper. Education is greatly reduced in cost, postage is cheapened, free libraries are open, sanitary measures are carried out, and such has been the general and substantial social improvement that life has been lengthened with a gain of two years in the average duration among males, and of nearly three and a half years among females. No such change could take place without a great increase in the vitality of the people.

We enumerate some of these points in this opportune and admirable paper that our readers may be attracted to read it with care, and not pass it by because of its length and its tabular statistics, which are, in fact, its most important part.

YALE PROFESSORS ON COLLEGE STUDIES.

The "Princeton Review" for March opens with an article, by Professor George P. Fisher, of Yale College, on "The Study of Greek," and to this succeeds an article entitled "Our Colleges before the Country," by Professor William G. Sumner, of the same institution. Both papers deserve attention. Dr. Fisher begins his discussion of Greek by making some concessions which are significant at the present time. He says:

> The defense of the classics is often based on exaggerated statements, and is really weakened by being placed on narrow grounds. It is idle to pretend that the study of the classics is as indispensable to culture now as it was three or four centuries ago.
>
> There is truth in Macaulay's sharp saying, that if "ancient literature was the ark in which all the civilization of the world was preserved during the deluge of barbarism," still we do not read "that Noah thought himself

bound to live in the ark after the deluge had subsided." At present there is an abundance of good reading in the modern languages. If the choice were given us whether to give to the flames the entire English literature of the last three centuries, or all the writings of the Greeks and Romans, the classics would have to perish. If we superadd to the English authors the German, French, and Italian writers of the modern period, there can be no question as to the literary value of the aggregate of these treasures when compared with the literature of antiquity, collectively taken. A man who has *studied* Lessing, Goethe, and Kant, Pascal, Molière, and Sainte-Beuve, Shakespeare, Milton, Locke, and Wordsworth, with Luther's Bible or the authorized English version, can not be regarded as an uncultured person, even if he has never opened the covers of a Latin and Greek classic. Still less can he be thus stigmatized if he has acquainted himself with Homer and Thucydides, Tacitus and Horace, Plato and Cicero, through the medium of fairly good translations into the vernacular.

The sweeping assertion sometimes hazarded, that classical training is in all cases necessary for distinctively literary excellence—for perfection of style—is contradicted by too many facts. Every one who has read the pages of John Bunyan, or the speeches of John Bright, knows better. Johnson was much more of a classical scholar than Goldsmith, but Goldsmith's English is far better than Johnson's. Native genius and tact have too large an influence in this matter to admit of any such universal rule or test as the classical bigots would lay down.

It is a very narrow view which holds that there is only one method of education—one beaten track on which all must walk.

It is not all persons who aspire after an intellectual life who are to be recommended to spend their time upon Greek, or even upon Latin. There is no good reason why many young persons, who devote a series of years to mental training in schools and colleges, should not, in case their aptitudes and intended vocation so prompt them, dispense with Greek, and pursue, in the room of it, the natural and physical sciences, or the modern languages, or both.

These cautious concessions, though no doubt entirely candid, have evidently been extracted from the professor by the strain which has been recently put upon the classical question, for he recognizes that the movement which broke out at Harvard College under the impulse of Mr. Adams's address, and which is understood to be favored by the president of that institution, will probably result in a modification of the collegiate course, and that "in this case the example of Harvard is likely to be followed by a greater or less number of other colleges." But, while yielding these several points, Dr. Fisher is careful not to surrender the main classical position, which is, to maintain the *prestige* of Greek and Latin as the essential elements of a broad, liberal education. He here stands upon the old ground and plies the old arguments, the most important of which seems to us strikingly unsatisfactory. Dr. Fisher says:

The objects of study, the object-matter, are the world and man. The "world" is here the synonym of nature. It embraces the physical universe, including the earth, its productions, and its inhabitants other than men. This is the realm of the natural and physical sciences. The grand progress of these studies is the most striking feature of the times, as regards the advance of knowledge. No one can be called an educated man at this day who is ignorant of the departments of inquiry which deal with nature. They provide, when earnestly pursued, a discipline of their own. But they can never supersede as a means of culture the study of MAN. This is the "proper study of mankind," the supreme object of curiosity, and source of mental and moral development. In this statement, religion is not forgotten; but it is through the contemplation of man primarily, and of nature, that we learn of God. Man—what he is, what he has thought and done, the civilization which he has created—this is that object of study, to which belongs a transcendent worth. In this study, embracing history, philosophy, politics, literature, religion, are the fountains from which cultivation is to be derived. To an individual cultivated thus, the sciences of nature gain a new quality, an ideal element, a suggestiveness, of which, independently of this advantage, they are destitute.

Man as an object of study is here separated from nature, and the separation is held to be so complete as to give rise to two great divisions of study. These are independent of each other, may be separately pursued, and result in two distinct systems of education.

Science may take nature, and the classics will appropriate man, as the respective objects of study. Dr. Fisher says:

> Now, at the foundation of a thorough and comprehensive survey of nature there lies one branch of knowledge. At the foundation of the thorough and comprehensive study of man there lies another. Each of these two fundamental studies is essential to the full understanding of things that now are—of nature as it is spread out before us, and of humanity in its present advanced condition. In other words, the present scene, in order to be radically comprehended, must be looked at in the light of these two fundamental studies.

Dr. Fisher then proceeds to work out this view, by referring to mathematics, which is a leading element in all liberal education, and showing its fundamental relation in the sphere of the sciences of nature; and he then makes the surprising affirmation that what mathematics is in the study of nature that also is classics in the study of man. He says, "Analogous to the relations of mathematics to the sciences of nature is the relation of the Græco-Roman history and civilization to our modern society." And, after referring to the historic position of the Greeks, the Romans, and the Hebrews, and their providential relation to modern affairs, he says, "As God has made nature mathematically, so he has governed the life and development of mankind as here indicated." The succeeding steps of the argument are obvious. To understand man and modern things we must study the ancients, and "how shall this knowledge of antiquity be obtained? It can be obtained after a fashion at second hand. But for a 'liberal' education, for that direct and penetrating view of ancient society which alone satisfies the ideal of such a culture, the languages of Greece and Rome must be learned. In the study of them the youth is put into immediate intercourse with the mind of the ancients. The veil is lifted."

Now, the first objection to this view is that, as a matter of fact, the veil is *not* lifted, and the minds of college youth are *not* "put into immediate intercourse with the mind of the ancients." It is notorious that, after five or ten years of study, "the average pupil can not read the Greek and Latin authors with any facility. Unable to read them, he lays them aside forever. Not unfrequently he sells the books which he has laboriously conned." Dr. Fisher, in referring to this objection, admits that it "can not be confuted by a sneer." It has so much truth that he recognizes it as "a deserved rebuke to methods of teaching which have come into vogue, and which loudly call for reform." This is a tacit confession that the study of Greek and Latin, which Dr. Fisher holds to be the key to a great department of knowledge concerning man and human society, is a total failure with the great mass of college students.

But the whole argument is futile. Man is not to be separated from nature as an object of study. He is a part of nature, and can only be understood as nature is understood, and by exactly the same mental procedures. Mathematics is a fundamental condition of the sciences of nature, and they can not be cultivated or understood without it. To say that the classical languages hold any such relation to the study of man is preposterous. We have man and all his activities and institutions before us, to be directly explored by observation, analysis, comparison, and all the perfected intellectual processes by which truth is established and knowledge extended. To be sure, we have not the ancients before us, but to understand them we had better study living men and existing society rather than to waste time on dead languages which, in nine cases out of ten, are never sufficiently learned to be of the slightest use for the purpose here contemplated. When living men are first studied and understood, translations will quite suffice to apply that knowledge to the interpretation of the ancients. That there is a science of man, though yet imperfect, and a science of mind rapidly growing, and a science of society roughly established, it is impossible to deny, and they determine for us the method of future investigation. And it is not by the study of ancient languages that these sciences have been created, nor is it by their ardent devotees that they are being now pursued and developed. As it is mainly by the men who have given the classics the go-by that all science has been cultivated, so it is to-day by men who are ignorant or not at all proficient in those old studies that the higher sciences pertaining to humanity are most vigorously and successfully pursued. And as it is not to the classicists but to the scientists that the world must look for further light on the nature, activities, and relations of man, so it is not to the dead languages but to the modern sciences that young men are to be commended to gain the best understanding of humanity, both in the present and the past.

Professor Sumner's article, "Our Colleges before the Country," is written from the thoroughly modern point of view. It is a breezy discussion of college tactics, and quite unprofessorial in the freedom of its criticisms of college functionaries' habits, ideas, and studies. Appreciating the merits of classical study, and acknowledging his own indebtedness to it, Professor Sumner is alive to its short-comings, the exaggerated claims that are made for it, and the bad results that flow from its prescriptive position in modern collegiate education. We quote some passages from this admirable article, some of which it will be seen are not without bearing upon the preceding discussion:

Now, however, the advocates of the old classical culture, ignoring or ignorant of all the change which has come over human knowledge and philosophy within fifty years, come forward to affirm that that culture still is the best possible training for our young men and the proper basis for the work of our colleges. How do they know it? How can anybody say that one thing or another is just what is needed for education? Can we not break down this false and stupid notion that it is the duty of a university, not to teach whatever any one wants to know, but to prescribe to everybody what he ought to want to know? Some years ago, at a school-meeting in one of our cities, a gentleman made an argument against the classics. A distinguished clergyman asked him across the room whether he had ever studied the classics. He replied that he had not. "I thought not," replied the clergyman, as he sat down. He was thought to have won a great victory, but he had not. His opponent should have asked him whether he had ever studied anything else. Where is the man who has studied beyond the range of the classical culture who retains his reverence for that culture as superior to all other for the basis of education? No doubt a man of classical training often looks back with pleasure and gratitude to his own education and feels that it has been of value to him; but when he draws an inference, either that no other course of discipline would have been worth more to himself, or that no other discipline can be generally more useful as a basis of education, he forms a judgment on a comparison one branch of which is to him unknown.

When, however, all this is admitted in regard to the uses of a classical training, what does it prove in regard to the claims of the classics to be made the basis of all higher education, or the toll which every one must pay before he can be admitted to the guild of the learned? Nothing at all. I have known splendid Greek scholars who could not construct a clear and intelligible argument of six sentences. They always became entangled in subtilties of phrase and super-refinement of words. I have known other great Greek scholars who wrote an English which was so dull that scarcely any one could read it. On the other hand, there are men whose names are household words wherever the English language is spoken, because they can say what they mean in clear, direct, and limpid English, although they have never had any classical culture at all. I have known whole classes to graduate at our colleges who had never read a line of Aristotle, and who had not a single correct notion about the life and polity of the Greeks. Men graduate now all the time who know nothing of Greek history and polity but the fragments which they pick out of the notes on the authors which they read. It is grotesque to talk about the recondite charms and graces of classical culture when one knows what it amounts to for all but here and there one. It is a rare thing for a man to graduate who has read Grote or Curtius, although he has studied Greek for five or six years. Any one who reads no Greek and never goes to college, but reads Grote or Curtius, knows far more of Greek life, polity, and culture than any but the most exceptional college graduate. I do not believe that this was formerly true. It appears that faithful students in former times used such means as then existed for becoming familiar with classical life and history far more diligently than is now customary. Classical studies, having sunk to a perfunctory character, now stand in the way of faithful study of anything.

I go further, and, if the classics are still proposed as the stem of a liberal education, to be imposed upon every student who seeks a university training, I argue that classical culture has distinct and mischievous limitations. The same may no doubt be said of any other special culture, and whenever any other culture is put forward as possessing some exclusive or paramount value, it will be in order to show that fact. I do not doubt that I gained great profit from a classical training. Part of the profit I was conscious of. I think it very likely that I won other profit of which I was unconscious. I know that it cost me years of discipline to overcome the limitations of the classical training, and to emancipate my mind from the limited range of processes in which it had been trained. For the last ten years I have taught political economy to young men of twenty-one years or thereabout who had been prepared for me by training in a curriculum based on classics. They have acquired certain facilities. They have a facility in "recitation" which is not always produced by familiarity with the subject. The art of recitation is an art all by itself. Very often it is all a man has won from his college training. Sometimes it consists in beating out a little very thin, so as to make it go a great way; sometimes it consist in "going on one's general information," and profiting to the utmost by any hint in the question; sometimes it consists in talking rapidly about something else than the question. Some men never can come to a point, but soar in lofty circles around and over the point, showing that they have seen it from a distance; others present rags and tags of ideas and phrases, showing that they have read the text, and that here and there a word has stuck in the memory without sequence or relation. The habit of reading classics with a "pony" for years has produced these results. Many of these men must be regarded with pity because their mental powers have been miseducated for years, and when they try to acquire something, to make it their own, to turn it into a concise and correct statement and utter it again, they can not do it. They have only acquired some tricks of speech and memory.

The case of men who have studied honestly, but who have been educated almost exclusively on grammar, is different. No doubt they have gained a great deal, but I find that they hardly ever know what a "law" is in the scientific sense of the word. They think that it is like a rule in grammar, and they are quite prepared to find it followed by a list of exceptions. They very often lack vigor and force in thinking. They either accept authority too submissively, if the notion which is presented does not clash with any notions they had received before, or, if they argue, they do so on points of dialectical ingenuity. They do not join issue closely and directly, and things do not fall into order and range in their minds. They seem to be quite contented to take things and hold them in a jumble. It is rare to find one who has scholarship enough to look up an historical or biographical reference. It is generally assumed by them that if "no lesson has been given out" they have nothing to do. One of the most peculiar notions is that a "lecture" has no such importance as a "recitation"; that to cut the former is of no consequence, but that to cut the latter is serious. In short, the habits and traditions in which men have been trained when they reach senior year in college are such that they are yet boys in responsibility, and, although they are very manly and independent in many respects, they are dependent and unmanly in their methods of study, in their conception of duty, in their scholarship, and in their code of conduct in all that affects the institution. It has been claimed for the classics that they give guidance for conduct. This is, to me, the most amazing claim of all, for, in my experience and observation, the most marked fact about classical culture is that it gives no guidance in conduct at all.

The tendency of classical studies is to exalt authority, and to inculcate reverence for what is written, rather than for what is true. Men educated on classics are apt to be caught by the literary form, if it is attractive. They are fond of paradoxes, and will entertain two contradictory ideas, if only each come in a striking literary dress. They think that they prove something when they quote somebody who has once said it. If any one wants to keep out "new ideas," he does well to cling to classical studies. They are the greatest barrier to new ideas and the chief bulwark of modern obscurantism. The new sciences have produced in their votaries an unquenchable thirst and affection for what is *true* in fact, word, character, and motive. They have taught us to appreciate and weigh evidence and to deal honestly with it. Here a strong contrast with classical training has been developed, not because classical training led men to be false, but because the scientific love of truth is something new and intense. Men of classical training rarely develop the power to go through from beginning to end of a course of reasoning on a straight line. They go on until they see that they are coming out at a result which they do not like. Then they make a bend and aim for a result which they do like, not regarding the broken continuity, or smoothing it over as carefully as possible. Classical training, in the world of to-day, gives a man a limited horizon. There is far more beyond it than within it. He is taught to believe that he has sounded the depths of human knowledge when he knows nothing about its range or amount. If any one wants to find prime specimens of the Philistinism which Matthew Arnold hates, he should seek them among the votaries of the culture which Matthew Arnold loves. The popular acuteness long ago perceived this, and the vile doctrines of anti-culture have sprung up and grown just in proportion as culture has come to have an artificial and technical definition, as something foreign to living interests.

SPENCER ON PARLIAMENTARY INFLUENCE.

Mr. Herbert Spencer, having been invited to allow his name to be submitted to the Liberal Association of Leicester as a candidate for Mr. Peter Taylor's parliamentary seat, has written a letter to the Rev. J. Page Hops, one of the committee, declining the invitation on several grounds. We reprint the communication:

38 Queen's-Gardens, Bayswater, W., *February* 21.

My dear Sir: While I am gratified by the compliment, and by the manifestation of sympathy implied in your proposal, I fear I can not respond to it in the way you wish. Several reasons, each of them sufficient, deter me.

In the first place, my health is such that discharge of parliamentary duties would be impossible. When I tell you that until last night I have not dined out for nearly a year, because I have been unable to bear the amount of excitement involved, you will see that it would be absolutely out of the question for me to undertake the nightly wear and tear which the life of a member entails. Even in the best state of that variable health which I have had these twenty-eight years, I am able to write, or rather to dictate, only three hours a day; and such being the case, you will see that the labors implied by active political life, could I bear them, would make it impossible for me to do other work. As I regard such other work as by far the more important—as I think I can do more good by endeavoring to complete what I have undertaken than by occupying myself in listening to debates and giving votes—I should not feel that I was doing right in exchanging the one career for the other.

Far too high an estimate is, I think, made of the influence possessed in our day by a member of Parliament, now that he has come to be, much more than in past times, subject to his constituents—now that the House of Commons as a whole is more and more obliged to subordinate itself to public opinion; the implication is, that those who form public opinion are those who really exercise power. It is becoming a common remark that we are approaching a state in which laws are practically made out-of-doors, and simply registered by Parliament; and if so then the actual work of legislation is more the work of those who modify the ideas of the electors than of those who give effect to their ideas. So regarding the matter, I conceive that I should not gain influence, but rather should lose influence, by ceasing to be a writer and becoming a representative.

But, apart from these general reasons, there is the more special reason that, if chosen by the electors of Leicester, I should prove a very impracticable member. My views on political matters are widely divergent from those of all political parties at present existing. That which I hold to be the chief business of legislation—an administration of justice such as shall secure to each person, with certainty and without cost, the maintenance of his equitable claims—is a business to which little attention is paid; while attention is absorbed in doing things which I hold should not be done at all. As I could not agree to be merely a delegate, voting as was desired by those who sent me, but should have in all cases to act on my own judgment, I should be in continual antagonism to my constituents, most of whom, Liberal as well as Conservative, hold opinions from which I dissent, and who would wish me to support measures which I entirely disapproved. Hence, even if elected, I should be quickly called upon to resign.

You will thus see that the choice of me as a candidate would be extremely impolitic, even had I no reason of a personal kind for declining to stand. Thanking you for your kind expressions, and regretting that I am unable to accede to your request, believe me, sincerely yours,

(Signed) HERBERT SPENCER.

To this letter the reverend gentleman to whom it was addressed replied, regretting that the state of Mr. Spencer's health and work would not permit him to engage in parliamentary duties, but declaring that the other reasons which Mr. Spencer assigned for not taking the nomination were most excellent reasons why he should consent to it. "Leicester," said Mr. Page Hops, "in the person of Mr. Taylor has had an admirable training in the art of letting its members alone, and I trust it will be still further developed in this direction. You certainly will never be called upon 'to resign' by such a constituency as ours; and I am truly sorry that your health and your work will not allow you to make proof of this."

In itself, this transaction is perhaps of small moment, but it has significance as showing that in England at least there is a decline in the consideration formerly attached to political office-holding, which is accompanied by an equally significant increase on the part of constituencies of resistance to partisan domination. When Mr. Spencer says that "far too high an estimate is made of the influence possessed in our day by a member of Parliament," this is not so much a mere personal opinion as the expression of a palpable and widely admitted truth. The letter has elicited extensive discussion, and the most influential organs of public sentiment in that country unhesitatingly acknowledge it. The "Pall Mall Gazette" remarks: "No one who has had any experience of the inner working of our constitution can gainsay this dictum. The real governing force in the country at present is not Parliament but public opinion, and the shaping of public opinion is a work which, in all but a few exceptional cases, can be much more effectively carried on outside Parliament than from within its walls."

But the offer of the Leicester constituency to be represented in Parliament by the most radical thinker in England, a man of no party, and holding views widely divergent from those entertained by both parties, is especially instructive as showing the value assigned to independence of thought, and the recognized supremacy of principles in English politics. Without assuming that this action of the Leicester politicians is at all representative of the intelligence and independence of other English constituencies, the general and quite emphatic approval of their course shows that it is in wide agreement with English thought. While it is generally admitted that Mr. Spencer did wisely in declining to enter Parliament, even if his bad health were not a barrier, and on the ground that he can do his work better outside of the parliamentary walls than within them, not a word of objection that we can discover has been raised on personal grounds, or because of the extreme and obnoxious opinions which it has become customary to impute to Mr. Spencer. The implication is that his non-partisan independence and his radical views would be excellent things in Parliament, but that his influence would be greater outside of it.

LITERARY NOTICES.

BACTERIA. By DR. ANTOINE MAGNIN and GEORGE M. STERNBERG, M. D., F. R. M. S. New York: William Wood & Co. Pp. 494. Price, $4.

DR. STERNBERG's translation of Dr. Magnin's work on "Bacteria," noticed in these pages at its first appearance three years ago, forms about one third of the present volume. In order to bring that treatise up to the present state of knowledge on the subject, Dr. Sternberg has added chapters on "Technology," "Germicides and Antiseptics," "Bacteria in Infectious Diseases," and "Bacteria in Surgical Lesions." Under the first head he describes methods of obtaining both natural and artificial culture-fluids uncontaminated, and gives directions for arranging culture-vessels and for examining the bacteria. His list of antiseptics includes some sixty substances, and he gives, besides the results of his own extended and careful tests of their powers, some results obtained by other investigators.

The diseases which have been supposed to depend upon the action of some micro-organism are also passed in review, and an abstract is given of what has been observed in regard to each. Dr. Sternberg reproduces from an earlier paper his statement of the *a priori* argument in favor of the existence of a yellow-fever germ, and then considers the experimental evidence which supports that view. "It must be admitted," he says, "that this is very unsatisfactory." His personal investigations are recorded in the "Preliminary Report of the Havana Yellow-Fever Commission of the National Board of Health," from which he quotes at length. "Having reported," he continues, "my own failure to find the yellow-fever germ, I must now refer to the recent announcements of its discovery in Mexico by Dr. Carmona, and in Brazil by Dr. Freire." In regard to the latter he says: "The writer is not prepared to estimate the value of the evidence here offered, inasmuch as we are not informed whether the yellow-fever blood used in the first inoculation experiment was obtained *post mortem* or *ante mortem*. . . .

"Hineman, a very competent German physician practicing in Vera Cruz, has not been more successful than the writer in finding the *Pernospera lutea* of Carmona, or *Cryptococcus xanthogenicus* of Freire, in the blood of yellow-fever patients before death. He examined the blood of patients in the last stage of the disease, taking blood from the hand, thinning it with artificial serum, *and bringing it at once* under the microscope. He says: 'In nine cases so examined not the slightest deviation from normal blood could be found. . . . No organisms were found.'" The volume is illustrated with twelve heliotype plates and thirty woodcuts, and contains a bibliographical list.

Flowers and their Pedigrees. By Grant Allen, author of "Colin Clout's Calendar," "Vignettes from Nature," "The Evolutionist at Home," etc., etc. New York: D. Appleton & Co. Pp. 266. Price, $1.50.

This is a very choice book, the best of an excellent class. England has at present no writer at all comparable to Grant Allen in the power of popularizing biological subjects. He is a thorough and accomplished student in a broad range of modern subjects involving the phenomena of life and mind, and their interpretation by the principle of evolution. He is as far as possible from being a mere compiler of other men's opinions, but gives a stamp of originality to his work, throwing light upon the subjects he treats by new suggestions, ingenious explanations, and the presentation of his topics in fresh aspects and new relations. He is, moreover, a writer of remarkable perspicacity and attractiveness, pleasant, easy, humorous, and a perfect type of the high-grade popularizer of science.

If this is warm praise, the book before us justifies it. It is spoken of by the English press in terms of very unusual commendation, and we entirely agree with one of them, which declares the volume to be "as interesting as any novel from the first page to the last."

We can do the author no better justice, and convey to our readers no clearer idea of the import of the book, than to reproduce its explanatory introduction:

Our beautiful green England is carpeted, more than any other country in the world, perhaps, save only Switzerland and a few other mountain-lands, with a perpetual sward of vivid verdure, interspersed with innumerable colors of daisies, and buttercups, and meadow-sweet, and harebells, and broader patches of purple heather. It is usual to speak of tropical vegetation, indeed, with a certain forced ecstasy of language; but those who know the tropics best know that, though you may find a few exceptionally large and brilliant blossoms here and there under the breadth and shade of equatorial forests, the prevailing tone is one of monotonous dry greenery; and there is nothing anywhere in very southern climes to compare, as to mass of color, with our Scotch hill-sides, our English gorse-clad commons, or our beautiful dappled meadows and cornfields, all aglow with the infinite wealth of poppies, bluebottles, foxgloves, ox-eye daisies, and purple fritillaries. The Alps alone can equal the brilliant coloring of our own native British flora. Poor as it is in number of species—a mere isolated fragment of the wider European groups—it can fearlessly challenge the rest of the whole world in general mingled effect of gayety and luxuriance.

Now, every one of these English plants and weeds has a long and eventful story of its own. In the days before the illuminating doctrine of evolution had been preached, all that we could say about them was that they possessed such and such a shape, and size, and color; and, if we had been asked why they were not rounder or bigger or bluer than they actually are, we could have given no sufficient reason, except that they were made so. But since the great principle of descent with modification has reduced the science of life from chaos to rational order, we are able to do much more than that. We can now answer confidently, Such and such a plant is what it is in virtue of such and such ancestral conditions, and it has been altered thus and thus by these and those variations in habit or environment. Every plant or animal, therefore, becomes for us a puzzle to be explained, a problem to be solved, a hieroglyphic inscription to be carefully deciphered. In the following pages, I have taken some half-dozen of familiar English weeds or flowers, and tried thus to make them yield up the secret of their own origin. Each of them is ultimately descended from the common central ancestor of the entire flowering group of plants; and each of them has acquired every new diversity of structure or appearance for some definite and useful purpose. As a rule, traces of all the various stages through which every species has passed are still visibly imprinted upon the very face of the existing forms: and one only requires a little care and ingenuity, a little use of comparison and analogy, to unravel by their own aid the story of their own remoter pedigree. This is the method which I have here followed in the papers that deal with the various modifications of the daisy, of the grasses, of the lilies, of the strawberry, and of the whole rose family.

Again, not only has each English plant a general history as a species, but it has also a separate history as a member of the British flora. Besides the question how any particular flower or fruit came to exist at all, we have to account for the question how it came to exist here and now in this, that, or the other part of the British Islands. For, of course, all plants are not to be found in all parts of the world, and their distribution over its surface has to be explained on historical grounds just as a future ethnologist would have to explain the occurrence of isolated French communities in Lower Canada and Mauritius, of African negroes in Jamaica and Brazil, or of Chinese coolies in San Francisco and the Australian colonies. In this respect, our English plants open out a series of interesting problems for the botanical researcher; because we happen to possess a very mixed and fragmentary flora, made up to a great extent of waifs and strays from at least three large distinct continental groups, besides several casual colonists. Thus while at Killarney we get a few rare Spanish or Portuguese types, in Caithness and the Highlands we get a few rare Alpine or Arctic types; and while in Norfolk and Suffolk we find some central European stragglers, the ponds of the Hebrides are actually occupied by at least one American pond-weed, its seeds having been wafted over by westerly breezes, or carried unconsciously by water-birds in the mud and ooze which clung accidentally to their webbed feet. Moreover, we know that at no very remote period, geologically speaking, Britain was covered by a single great sheet of glaciers, like that which now covers almost all Greenland: and we may therefore conclude with certainty that every plant at present in the country has entered it from one quarter and another at a date posterior to that great lifeless epoch. This, then, gives rise to a second set of problems, the problems connected with the presence in England of certain stray local types, Alpine or Arctic, southern or transatlantic, European or Asiatic. Questions of this sort I have raised and endeavored to answer with regard to two rare English plants in the papers on the hairy spurge and the mountain tulip.

In short, these little essays deal, first, with the evolution of certain plant types in general; and, secondly, with their presence as naturalized citizens of our own restricted, petty, insular floral commonwealth.

Record of Family Faculties: Consisting of Tabular Forms and Directions for entering Data, with an Explanatory Preface. Pp. 64. Price, 90 cents. Also, Life-History Album. Pp. 170. Price, $1.25. By Francis Galton, F. R. S. London: Macmillan & Co.

The "Record of Family Faculties" "is designed for those who care to forecast the mental and bodily faculties of their children, and to further the science of heredity," being arranged for entering descriptive and historical data in regard to the fourteen direct ancestors which constitute the three generations immediately preceding a family of children.

Space is allowed also for descriptions of brothers and sisters of these ancestors, and of other relatives about whom little is known. Some of the entries called for are: "Mode of Life, so far as affecting Growth or Health; Bodily and Mental Powers, and Energy, if much above or below the Average; Favorite Pursuits; Minor Ailments, and Graver Illnesses; Cause and Date of Death, and Age at Death." In the preface Mr. Galton rebukes the vanity of those who parade the fact of their descent from some distant, illustrious ancestor, and remarks that "one ancestor, who lived at the time of the Norman Conquest, twenty-four generations back, contributes (on the supposition of no intermarriage of kinsfolk) less than one part in 16,000,000 to the constitution of a man of the present day." He deems three generations far enough to go back for hereditary information, except that any distinctly alien element of race or disease, which has been introduced earlier, should be noted. Mr. Galton holds that "the natural gifts of each individual being inherited from his ancestry, it is possible to foresee much of the latent capacities of a child in mind and body, of the probabilities of his future health and longevity, and of his tendencies to special forms of disease, by a knowledge of his ancestral precedents. When the science of heredity shall have become more advanced, the accuracy of such forecasts will doubtless improve; in the mean time we may rest assured that fewer blunders will be made in rearing and educating children, under the guidance of a knowledge of their family antecedents, than without it." As a stimulus to the making of these records, Mr. Galton has offered £500 in prizes "to those British subjects resident in the United Kingdom who shall furnish him before May 15, 1884, with the best extracts from their own family records."

The "Life-History Album" is arranged to contain the biological experience of one person, and is to be begun by the parents of a child and continued by the person himself from the time that he becomes old enough. It is expected to prove of service in the following ways: "1. It will show whether, and in what way, your health is affected by the changes that take place in your residence, occupation, diet, or habits. 2. It will afford early indication of any departure from health, and will thus draw attention to conditions which, if neglected, may lead to permanent disorder. . . . 3. A trustworthy record of past illnesses will enable your medical attendants to treat you more intelligently and successfully than they otherwise could, for it will give them a more complete knowledge of your 'constitution' than could be obtained in any other way. . . . 4. The record will further be of great value to your family and descendants; for mental and physical characteristics, as well as liabilities to disease, are all transmitted more or less by parents to their children, and are shared by members of the same family."

The first page of the "Album" is for a "Description of Child at Birth," and there is a leaf each for a "Record of Life History," "Record of Medical History," "Anthropometric Observations," and "Photographs" for each five years of life up to seventy-five. There are also charts on which to record the stature and weight—one for each five years up to twenty-five, another for a summary of these five; one for the years from twenty-five to fifty, and one for the years from fifty to seventy-five. On each chart except the last are printed curves showing the average stature and weight of the male and female population of the United Kingdom, so that the individual may compare the curves which he constructs for himself with these. The appendix contains tests of vision, notes on apparatus, etc.

Clavis Rerum (The Key of Things). Norwich: F. A. Robinson & Co. Pp. 142. Price, $1.

This book embodies the conclusions of its author in regard to the plan of the universe. He names six modes of being as elements in which the universe subsists, viz., matter, force, life, soul, spirit, and God, defining soul as "that mode of being which is characterized by intellect and will," and spirit as "that mode of being which is characterized by consciousness of God." In his closing chapter, "Consummation," he says: "Matter, force, life, soul, and spirit, came forth from God in order that, by the interior operation of their several laws, they might be fitted to return to him. . . . The return of the extrinsic universe, through human nature, into God, is accomplished by the incarnation of the Word, and by the personal union with him of all other perfect individual men."

Bleaching, Dyeing, and Calico-Printing. With Formulæ. Edited by John Gardner, F. I. C., F. C. S. Philadelphia: P. Blakiston, Son & Co. Pp. 203. Price, $1.75.

In the chapter on "Bleaching," after a brief historical review, cotton, linen, woolen goods, silk, feathers, paper materials and paper, straw, and wax, are successively taken up, and the outlines of the processes are given in each case. In the second chapter some thirty formulæ for dyeing cotton are given, and twenty for dyeing wool and silk. Several modes of calico-printing are sketched, and the formulæ for a large number of styles are given. There is a fourth chapter in which a short account is given of each of the important dye-stuffs. The aim of the editor has been to compile "a ready and serviceable manual for practical workers," which may be referred to with the expenditure of less time and trouble than is necessary with such larger and more elaborate works as Crookes's "Practical Hand-Book of Dyeing and Calico-Printing," Ure's "Dictionary," Wagner's "Chemical Technology," and others, which have been consulted in the preparation of the volume.

Proceedings and Transactions of the Royal Society of Canada, 1882 and 1883. Montreal: Dawson Brothers.

The Dominion to the north of us is constantly evidencing more and more of national life. Since 1867, when the British provinces became a confederation, Canada has shown an energy and enterprise which would have been impossible to a series of separate colonies having no bond of political unity. Within the last few years, the development of railways and manufactures in Canada has quite paralleled that of the United States, and, in the higher matters of public and university education, the Dominion exhibits an advance which is full of promise for her future. Among the proofs that our northern neighbors are progressing in matters of broad, national culture, none can be more satisfactory than the establishment, by the Marquis of Lorne, of the Royal Society of Canada two years ago. The society, founded on the lines of its great English prototype, is intended to promote literature and science; and, in bringing together the most eminent scholars and scientists of the country, will undoubtedly attain the good results of mutual help, criticism, and emulation which attend such assemblages the world over. The society consists of four sections: French literature, history, and allied subjects; English literature, history, and allied subjects; mathematical, physical, and chemical sciences; geological and biological sciences. The presidents of these sections, who were appointed by the Marquis of Lorne for the purpose of organizing the society, were Messrs. J. M. Lemoine, Daniel Wilson, T. Sterry Hunt, and A. R. C. Selwyn. The first president of the society was Principal Dawson, of McGill University, who was succeeded last year by Dr. P. J. O. Chauveau, of Montreal, and in 1884 that city will again give the society its president in the person of Dr. T. Sterry Hunt.

The Proceedings and Transactions before us are not only valuable in themselves, but they give us incidentally some interesting insight into the peculiarities of Canadian national life. That the papers by the French-Canadian members should be published in their language is enough to show that the element they represent in the population is very far from genuine assimilation with their compatriots of British descent. Indeed, competent observers of the situation declare that the adhesion of the French Canadians to their language, religion, laws, and institutions was never firmer than now. Is America to behold the development of a race French in speech, customs, and sentiment? Is the province of old Quebec to be thus reconquered by France after all? Surely no better topic than this curious phase of Canadian sociology could be treated in the next volume of Transactions which the Royal Society of Canada will publish to the world. Perhaps the causes lie in the wonderful fecundity of the race, the contentment with narrow fortunes which keeps so many of them at home, and the indulgent policy toward them by Great Britain—that empire which, having lost its best group of colonies by harsh treatment, seems determined in Canada to retain the allegiance of a conquered race by a noble magnanimity.

The volume before us manifests the influence which the classical and literary education of French Canadians has had on their scientific culture. Although numbering one fourth of the nation, their representatives in the Royal Society are but one eighth the membership of the two scientific sections; and, while the scientific contributions of the French-speaking members are scarcely up to the standard of those from their British *confrères*, in the literary departments, the papers in French have a grace and beauty of style which show that the language of France has lost nothing by its study having been transferred to America for more than two centuries. The sketches of the first settlers of Canada are sufficiently well given to deserve introduction to the readers of the continent.

Dr. Daniel Wilson's paper, on the pre-Aryan American man, is a valuable contribution to the study of the Indian tribes, upon whose history discovery and research are every year throwing more light. Dr. Alpheus Todd, the constitutional historian, whose death occurred last January, has given us a paper on the establishment of free public libraries, with valuable hints derived from his long experience as parliamentary librarian.

The scientific contributions to the Transactions are noteworthy. With an area for the scope of the naturalist as extensive as our own, the range of research and exploration in the Dominion affords splendid opportunities to her men of science. In developing knowledge concerning the vast territory of Canada, the Geological Survey has done noble work. That survey, mainly established by the exertions of the late Sir William E. Logan, with the co-operation of Dr. Hunt and Mr. Billings, has given scope to the acumen and research of men such as the Dawsons, father and son, Bell, and Harrington, whose labors in the fields of systematic geology and paleontology are known and valued by the students of both Europe and America. The volume before us gives a paper by Principal Dawson on the cretaceous and tertiary floras of British Columbia and the Northwest Territories, eight fine quarto illustrations accompanying his paper. His son, Dr. George M. Dawson, describes a general section of the geology from the Laurentian axis to the Rocky Mountains. Dr. T. Sterry Hunt contributes a paper on the geological history of serpentines, wherein he defends by new arguments their aqueous origin, a thesis which he has long maintained. Incidentally to this, he condenses into a few pages the history of the pre-Cambrian rocks of Southern Europe with their included serpentines, and shows in this connection that the great groups of these rocks previously pointed out by him in America are equally developed in the Old World. In his memoir on the Taconic question in geology, Dr. Hunt begins by a tribute to the labors of Amos Eaton, the founder of American stratigraphical geology. He then gives in detail an account of the so-called Taconian or Taconic rocks, the true age of which has been the subject of so much dispute; by a wide induction of facts gleaned from all Eastern North America, he proceeds to show that these rocks are of pre-Cambrian age, and probably paralleled with the youngest pre-Cambrian group of the Alps described by him in his preceding memoir. These rocks, it may be said, in their wide range of distribution, include the white statuary marbles of both Vermont and Italy. This paper, of some fifty pages, is the first half of Dr. Hunt's elaborate memoir, and terminates in a comprehensive review of the early geological history of Eastern North America.

Although geology is much the best represented science in these Transactions, the other departments of the sections give us original papers of value. Dr. E. Haanel contributes an account of experiments in using hydriodic acid as a blow-pipe reagent, and four remarkably well-executed plates in colors serve to illustrate his paper. A series of reports of the transit of Venus, December 6, 1882, show the wide interest taken in that event in the chain of Canadian cities stretching from Montreal to Winnipeg. The observations, as a whole, were satisfactory.

Dr. Robert Bell's explanation of the causes of the fertility of the Northwest shows the immense variety of natural forces which decide whether a region shall or shall not furnish a nation with food and fuel. Mr. W. Saunders's papers on Canadian forestry and on the noxious insects of the country are suggestive and timely.

The publishing committee of these Transactions remark with pardonable pride that the paper, type, and illustrations are all of home production.

A System of Rhetoric. By C. W. Bardeen. New York: A. S. Barnes & Co. Pp. 814. Price, $1.50.

Part I of this book is entitled "Sentence-Making," and contains a large amount of such matter as is usually found in the "false-syntax" section of grammars. Part

II is on "Conversation," and, besides directions for attaining the purposes of conversation, includes chapters which treat of elocution, etiquette, and the minor moralities of the subject. Under "Letter-Writing" letters are treated in the classes "of Friendship, of Courtesy, of Business, to Newspapers"; bad penmanship and allied sins are touched upon, and chapters on "Narration," "Description," and "Punctuation" are added. Then follow three forms of discourse, which, as the author remarks, need not be practiced by all persons. The chapters under "The Essay" treat of the subjects to which rhetorics generally are mainly devoted. Under "Oratory" are discussed "Eloquence, Argument, Extemporaneous Speaking, and Delivery." The treatment of "Figurative Language" is placed under "Poetry," together with a discussion of "What constitutes Poetry?" and a chapter on "Rhythm."

Energy in Nature. By William Lant Carpenter, B. A., B. Sc., F. C. S., etc. Illustrated. London, Paris, and New York: Cassell & Co., limited. Pp. 212. Price, $1.25.

There is a large and growing class of persons, who, while they do not care to make a close study of any special branch of physical science, yet desire to know what additions are being made to the knowledge of those general principles which underlie the phenomena of nature, and who desire also to understand how these principles are applied in the wonderful mechanical contrivances which they see multiplying about them. To this constituency Professor Carpenter has addressed the present volume, which contains, with some additions, the substance of a course of six lectures upon the "Forces of Nature and their Mutual Relations," delivered under the auspices of the Gilchrist Educational Trust, in the autumn of 1881. "The book may be shortly described," says the author, "as an endeavor to expound in popular yet accurate language the meaning and consequences of that important principle known as the conservation of energy. Considerable pains, however, have been taken, especially in dealing with electricity, to illustrate and explain the very latest developments of the subjects treated in the text, since the transformation of mechanical into electrical energy by the dynamo-machine is a remarkably good example of the general principle." The illustrations used in presenting the subject are generally "matters of common experience," and hence many interesting explanations have found their way into the volume.

A Defense of Modern Thought: In Reply to a Recent Pamphlet by the Bishop of Ontario on "Agnosticism." By William D. Le Sueur, B. A. Toronto: Hunter, Rose & Co. Pp. 40. Price, 15 cents.

We printed a portion of this masterly pamphlet last month, and the interest it has excited on the part of many to see the whole of the argument makes desirable this further reference to it. Everybody should be obliged to the lord bishop for having printed his discourse, not because of any value it had in itself, but because of the ability of the reply it elicited. Mr. Le Sueur's exposition needs no praise, but we applaud his fidelity to duty in so effectually exposing the weakness of the bishop's case, and then in printing the criticism at his own expense, as probably the publishers thought it would be no speculation for them. Let every one who was gratified with the fragment we furnished, and interested to see the remainder, send a dollar to the publishers to get as many of the pamphlet as it will bring. Extra copies will be excellent to give away.

A Plea for the Cure of Rupture. By Joseph H. Warren, A. M., M. D. Boston: James R. Osgood & Co. Pp. 117, with Plates. Price, parchment, $1.

The essay which gives the title to this book—"A Plea for Operative Measures for the Relief and Cure of Hernia"—was a paper read before the meeting at Liverpool of the British Medical Association, and is published, with very slight alterations, as it originally appeared in the Association's journal. A chapter is given on tissue-repair, with a brief summary of the application and operation of the method of subcutaneous injection. An account of the new *conformateur* for showing the contour of hernia, etc., a paper on the causation of hernia, and a paper on the proper fitting and wearing of trusses, etc., have been contributed by fellow-physicians of the author.

The Topographer; His Instruments and Methods. Illustrated with numerous Plates, Maps, and Engravings. By Lewis M. Haupt, A. M., C. E. Philadelphia: J. M. Stoddart. Pp. 184. Price, $4.00.

This book is designed for the instruction of students. It opens with a chapter on "How and what to observe," which is followed by one on "The Instrumental Outfit," in which are described, with cuts, the prismatic compass, chronometer, barometer, odometer, pedometer, clinometer, sextant, hand-level, heliotrope, reflector, and range-finder, the name of some maker being given with each. The next three chapters are on "Scales of Maps," "Forms of Record," and "Graphical Representations," and are supplied with diagrams and tables for illustration and reference. Under "Instruments and Methods used in 'Filling in,'" directions are given for making stadia measurements, for the use of the plane-table, and of the transit. Directions for determining the true meridian follow, with descriptions of two forms of solar transit. Short chapters are devoted to "Hydrography" and "Underground Topography,"; "Field Sketching," "Computations," and "Modeling" are taken up successively, and the final chapter is devoted to "Applications," in which are considered the locating of common roads, railroads, canals, and pipe-lines; irrigation, aqueducts, and the locating of cities. Among the accompanying maps may be mentioned one of the Yellowstone National Park, one of the floor of the Mammoth coal-bed in the vicinity of Summit Hill, Carbon county, Pennsylvania, and charts of Hampton Roads, and Boston Bay.

PUBLICATIONS RECEIVED.

Houghton Farm: Experiment-Orchard and Peach-Yellows. New York: Print of "The Hub." Pp. 64.

The Rocky-Mountain Locust and the Chinch-Bug. Entomological Division, Department of Agriculture. Washington: Government Printing-Office. Pp. 36.

The Disease of Inebriety and its Social-Science Relations. By T. D. Crothers, M. D. Hartford, Conn. Pp. 14.

Reports of Experiments on Insects injuriously affecting the Orange-Tree and the Cotton-Plant. Entomological Division, Department of Agriculture. Washington: Government Printing-Office. Pp, 62.

Reports of Observations and Experiments in Practical Work. Division of Entomology, Department of Agriculture. Washington: Government Printing-Office. Pp. 72, with Three Plates.

Observations of Comets, 1880–1882. Cincinnati Observatory. Pp. 80, with Nine Plates.

Experimental Determination of Wave-Lengths in the Invisible Prismatic Spectrum. By S. P. Langley. Pp. 20.

Distribution of Gluten within the Wheat-Grain. By N. A. Randolph, M. D. Philadelphia. Pp. 5.

The Quaternary Gravels of Northern Delaware and Eastern Maryland. By Frederick D. Chester. Pp. 12.

A Case of Recurrent Dropsy of the Left Middle Ear. By Drs. Charles H. Burnett and Charles A. Oliver. Pp. 26.

Meeting of the International Prison Congress at Rome, in October, 1884. U. S. Bureau of Education. Washington: Government Printing-Office. Pp. 11.

Bulletin of the Philosophical Society of Washington, 1883. Washington. Pp. 168.

"The Canadian Record of Natural History and Geology." J. T. Donald, Editor. Montreal: John Lovell and Son. Pp. 64.

Transactions of the Ottawa Field Naturalists' Club. Ottawa, Canada: Citizen Printing and Publishing Company. Pp. 90, with Plate.

The Fæces of Starch-fed Infants. By N. A. Randolph, M. D. Philadelphia. Pp. 4.

Medical Thoughts of Shakespeare. Compiled by B. Rush Field, M. D. Easton, Pa.: "Free Press." Pp. 16.

Biogen. By Professor Elliott Coues. Boston: Estes & Lauriat. Pp. 66.

The Railroad as an Element in Education. By Professor Alexander Hogg. Louisville, Ky. Pp. 22.

Tenth Annual Report of the Zoölogical Society of Cincinnati. Pp. 16.

Report of the New York State Survey for 1883. James T. Gardiner, Director. Albany: Van Benthuysen Printing-House. Pp. 182, with Six Maps.

The External Therapeutics of Pulmonary Consumption. By Dr. Thomas J. Mays. Upper Lehigh, Pa. Pp. 20.

House-Drainage. By William Paul Gerhard. New York: Durham House-Drainage Company. Pp. 44.

Reflex Nervous Influence and the Causation and Cure of Disease. By Dr. D. T. Smith. New Orleans, La. Pp. 11.

"Miscellaneous Notes and Queries, with Answers." January and February, 1884 (double number). Manchester, N. H.: S. C. and L. M. Gould. Pp. 24 + 16 + 16. 20 cents; $1 for ten numbers.

Pilot-Chart of the North Atlantic for March, with Supplement of 5 pages. By Commander J. R. Bartlett. Washington: U. S. Hydrographic-Office.

Susceptibility to Malaria, or Personal Predisposition to Malarial Fevers. By Dr. J. P. Dake. Nashville, Tenn. Pp. 9.

Medical Legislation in the United States. By Dr. J. P. Dake. Nashville, Tenn. Pp. 14.

Hygienic Institutes. By Professor George A. Smyth. Pp. 27.

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POPULAR MISCELLANY.

Edward J. Hallock, A. M., Ph. D.—It is with much regret that we have to announce the death, on March 22d, of Dr. Hallock, for many years a contributor to this journal. He was born in Peekskill, New York, on the 19th of June, 1845. His early education was in the local schools of his birthplace, ending with the Peekskill Military Academy. In 1865 he entered Columbia College, whence he graduated four years later, receiving the degree of Bachelor of Arts. He was the recipient of the first prize in German, and in 1872 the college also conferred upon him the degree of Master of Arts. Soon after graduating he sailed for Germany, and commenced the study of chemistry in the University of Berlin. In 1870 he returned to this country, and was appointed assistant to President Parrish, of Swarthmore College, near Philadelphia. Upon President Parrish's resignation, he too resigned, and, leaving Swarthmore College, was appointed assistant to Professor Joy, occupying the chair of Chemistry in Columbia College. This place he held for several years, acting as professor during Dr. Joy's illness. He went to Germany again in 1877, and was assistant to Professor Hofmann, in Berlin, and received in 1878 the degree of Doctor of Philosophy from the University of Heidelberg. Returning then to this country, he was for two years Professor of Chemistry in the Southern Medical College, Atlanta, Georgia. Since 1878 he had been engaged in a large field of scientific work, lecturing in many educational institutions, and acting on the editorial staff of the "Boston Journal of Chemistry" and the "Journal of Applied Chemistry." He was a contributor also to many of the scientific journals of this city. Two laborious chemical indices are his work: one an "Index to the Literature of Titanium," the other an "Index to the Literature of Glucose," the latter prepared, at the request of Dr. C. F. Chandler, for the National Academy of Sciences. Both of these have been published, the latter appearing only a short time before his death. His last piece of literary work was a sketch of his German master in chemistry, Dr. Hofmann, which appeared in the April "Popular Science Monthly."

Dr. Hallock was a man of simple manners, modest to a fault, and with great sincerity and uprightness of character. He carried this trait into all his work. He was an excellent scientific teacher, and aimed at thoroughness as the first object of instruction. He lectured before many popular schools, and his patience was greatly tried by the tendency he constantly encountered on the part of their managers to make the lectures showy and sensational, so as to captivate ignorant patrons and advertise the institution.

On the Supposed Discovery of Iron in Prehistoric Mounds.—It has been generally understood that an iron or steel sword was found many years ago by Dr. Hildreth in one of the prehistoric mounds at Marietta, Ohio, and that an iron blade and a plate of cast-iron were found by Mr. Atwater in a mound at Circleville; and these supposed facts have been used to maintain the supposition that the mound-builders were acquainted with iron, or had intercourse with people who had iron; or that the mounds were erected after the builders came in contact with Europeans, or have been intruded upon since they were built. The discovery, during the past year, of masses of meteoric iron and several ornaments made of it in mounds in the Little Miami Valley has caused Professor F. W. Putnam to review the statements that have been made in relation to the subject. Examining the original statements from which these deductions have been drawn, he finds that the evidence does not show that steel or iron was found. Dr. Hildreth described as among the articles found at Marietta "three large circular bosses, or ornaments for a sword-belt, or a buckler," composed of copper, overlaid with a thick plate of silver. Dr. Atwater found at Circleville a piece of antler, in one end of which a hole had been bored, bound with a band of silver, which he called "the handle either of a small sword or large knife," and distinctly states that "no iron was found, but an oxide remained of similar shape and size." On the same page he speaks of "a plate of iron, which had become an oxide, but, before it was disturbed by the spade, resembled a plate of cast-iron." This oxide, Mr. Putnam says, in the absence of exact evidence, "could be readily accounted for by one familiar with the traces of oxidized copper, iron-colored clay, and traces of oxide of iron, which are often met with in mound explorations." Professor Putnam compares the 'bosses' described by Hildreth with similarly-shaped articles of copper found in mounds in Franklin, Tennessee, and in the Little Miami Valley, which were evidently ear-ornaments, and decides that they were of the same character. Dr. Hildreth also describes "a plate of silver, which appears to have been the upper part of a sword-scabbard; it is six inches in length and two in breadth, and weighs one ounce; it has no ornaments or figures, but has three longitudinal ridges" (there are actually five), "which probably correspond with edges, or ridges, of the sword." This is compared by Professor Putnam with a similar article of copper from Franklin, Tennessee, and another of meteoric iron from the Little Miami, which were evidently not sword-scabbards, though their precise use can only be conjectured. Thus, "not a shadow of a sword can be traced in this connection; the point of the supposed scabbard is a common copper bead; the upper part of the scabbard is an ornament of a particular pattern, of which three others almost identical in shape are known from other mounds; and the 'bosses' or supposed ornaments of a sword-belt are ear-rings." Dr. Hildreth states, however, that a piece of iron-ore was found in his mound, and Professor Putnam regards this statement as of great interest, "now that we know from the discoveries of the past year that the peculiar and malleable qualities of meteoric iron were known to the builders of the group of mounds in the Little Miami Valley." The ear-ornaments, he also observes, "exhibit a degree of skill in working the native metals of copper, silver, and iron, simply by hammering, which is conclusive evidence of the advance made by early American tribes in ornamental art."

Unscientific Science-Teaching.—Dr. W. B. Carpenter, in discussing a paper on "Science-Teaching in Elementary Schools," recently read before the London Society of Arts, said that "the facts and conclusions stated in the paper entirely accorded with his own experience; and he also agreed with what Dr. Gladstone had said on the importance of what might be called living knowledge of these subjects, in opposition to dead knowledge. For instance, the use of an air-pump had been referred to: nobody could teach a child the action of a pump or the use of a barometer without explaining the pressure of the air, but that was merely a form of words unless the child had the air exhausted from under his hand, and felt that a considerable force was necessary to withdraw it. From a long experience of examinations, he could entirely indorse what had been said of the cramming system of getting up subjects from books. He had examined in science for the Indian Civil Service, and had often found candidates giving the most excellent descriptions, entirely from memory, out of books, of objects which they did not even know by sight when put before them. That was not scientific knowledge at all, it was merely something committed to memory; the only use of which was that it exercised the memory, but it did not exercise the capacity for observation and reasoning upon observation, which was the special value of scientific teaching. . . . A daughter of the late Robert Chambers, some years ago, took much interest in introducing the teaching of animal physiology into primary schools, and she used to go into one of the schools in the Cowgate, Edinburgh, twice a week, and give lessons in it, and no doubt her teaching was of the most attractive kind; at any rate, the children were so much interested in it that some of the clerical managers of the school were annoyed that the children cared so much more for this subject than for their ordinary lessons. No doubt there was a great deal of teaching about the dimensions of the tabernacle, and the number of fringes on the high-priest's garments, and so on, which the children did not appreciate so much as the animal physiology, and the result was that Miss Chambers was asked to discontinue; but the children held a meeting, and passed resolutions that they would not come to school at all if she were not allowed to go on; and, as she described, the clergy came and requested her to continue her teaching. This was a good illustration of the fact, which all who attended to the subject knew, that science well taught was apprehended by children in a remarkable degree. A very young child apprehended what was put before it intelligently; and, in an older child, reasoning went on concurrently with observation." Dr. Armstrong, who also joined in the discussion, remarked that "schoolmasters might say to men of science: 'You are no doubt right in the main in urging us to teach science, but you have not yet put before us a proper method of teaching science; it is not yet sufficiently developed; there are too few teachers.' And when a schoolmaster asked what book you would recommend him for teaching any particular science, they were compelled to confess that they could not honestly recommend any, for most text-books were tainted, more or less, with the vice which had been alluded to—that they tended rather to teach bare facts than to develop the intellectual faculties. What was wanted was more co-operation on the part of those who understood the subject, not a few people here and there introducing systems of their own. They also wanted instruction as to the meaning of science; the public generally did not know what science meant; and had no idea that the intention was to teach boys and girls to use their eyes and their minds."

A Crab-Shell Barometer.—The southernmost province of Chili comprises the Chiloe Islands, on which a remnant of the Araucanian Indians still exists, in a population of whites, Indians, and mixed. There is so much moist and wet weather on these islands that the prognostications are mainly directed to tell the fair weather. The natives use a curious instrument for this purpose, known as the "*Barometro Araucano.*" It is the exuviated or cast-off shell of an *Anomuran* crab, probably of the genus *Lithodes.* This dead shell is peculiarly sensitive to atmospheric change. In dry weather it remains nearly white, but with the approach of moisture small red spots appear on the shell, increasing in number and size with the increase of humidity, until the rain comes, when the shell becomes all red, and retains this color throughout the wet season.

The Swiss Society of Natural Sciences.—The Swiss Society of Natural Sciences held its sixty-sixth annual reunion at Zurich in August, and was attended by men from many countries. The meeting was opened by M. Cramer, Professor of Botany in the University of Zurich, with an address, in which, besides reviewing the progress of the natural sciences, he laid particular stress upon the study of the minute organisms which have recently been brought into prominence. Professor Meyer traced the progress of chemistry under the influence of the ideas of Mendelejeff and L. Mayer, and showed how a classification had become possible of all simple solids under five distinctly separated families. The likenesses on which the classification is based are so strong that the discovery of gallium was foreseen; its density and atomic weight were determined three years before the element was actually separated by the French chemist M. Lecoq de Boisbaudran. Professor Meyer concluded his address by showing how science is indebted to men who think, who found theories on experiments, and then verify the truth of their hypotheses by renewed investigations. Professor

Hermann Fol, of the University of Geneva, described his studies on animal individuality, embracing particularly his researches into the origin of double beings, two-headed monsters, and the like. Professor F. A. Forel presented an interesting paper on the variations of temperature of the Swiss lakes, which he has made the subject of several years of study. Professor Suess, of Vienna, read a paper in exposition of the modern theory of the upheaval of mountains. Professor Clausius, of Berne, was elected president of the society.

False Knowledge.—Dr. Oliver Marcy, geologist and classicist, and formerly President of the Northwestern University, has some sensible remarks on educational fallacies, in the Chicago "Evening Herald": "There is much wrong education. The human mind is burdened with false knowledge. It comes to us in tradition. It constitutes a large part of our libraries. All the false notions of the ancients stand upon our shelves. False knowledge is forced upon us in the instruction we receive. We are taught that we must go to school to the ancients; that they had the truth, and knew more and were wiser than the people of this age; that in the art of composition, both in prose and in poetry, the moderns are inferior to the men of ancient time; that it is necessary, in order to acquire a good style in English, to study composition in Greek, a language whose structure is wholly unlike that of the English. The Greek mythology is represented as a beautiful blossom of the human intellect, worthy of years of patient study. We are taught that a man educated in the knowledge that existed 300 years before Christ is better educated than a man educated in the knowledge of the nineteenth century. If these are not fallacies, what ground have we for expecting that the human race will have any better mental condition in the future? If these are not fallacies, what has become of the law of progress? One of the most detrimental fallacies imbibed with our education is the notion that words have a potency of meaning in themselves. The truth is, they have only such meanings as we attach to them. They stand for notions already in our minds. When uttered or written they have no power to generate the same notions in other minds as they represent to us, unless the other parties have associated these same notions with the sounds we utter or sets of visible marks similar to those we write. Meaning does not exist in a word by virtue of its root or its history. Roots and word histories are of interest in the study of words as such in philology, but, in the selection of a word to express an idea, the question is not what the word has stood for in the minds of persons long since dead, but what it stands for now in the minds of the living. The new meaning of every word is different from its old meaning, and in some cases the new meaning is directly contrary to that of the old. No one can obtain the new notion from the study of the old word; for instance, the notion which is now represented by the word animal. The Greek *anemos* stood for wind and for a breath. The Latin *anima* stood for spirit and life, as then understood. The Latin *animal* stood for a living being; but no Roman or Latin ever used this word to represent the idea for which the word now stands in the mind of the scientific man, for the modern idea had no existence in those days. The man whose vernacular is the English tongue takes a very indirect route, and makes a very unproductive journey, when he seeks the meaning of the now English word animal through its roots and its history. The present meaning can be obtained only by observing and studying animals themselves in connection with the thoughts and observations of modern investigators. Persons who get into the habit of obtaining their ideas from Latin and Greek roots generally have no disposition to seek knowledge in any other way. They are satisfied with the imperfect notions which they thus obtain from the old words, and forever remain ignorant of the real nature of the things for which the new words stand. Agassiz was so impressed with the fallacy of names that he never permitted his students to know the name of an object of study till they had formed a proper notion of it by a minute study of the object itself. Names to the ignorant convey but very superficial notions. These fallacies are affecting the education, the life, and the thinking of all our people. We should throw them off as we grow in clear thinking, as the growing lobster throws off his shell. There is much confusion of mind produced by words which become fashionable for a time, and are made to carry a great variety of meanings, and frequently no definite meaning. Such a word is 'culture.' Arnold has defined it, and Huxley has lectured on his definition, and Mr. Arnold has lectured in reply. Still, though it is used every day, no one can tell exactly what it means. The common notion attached to it is that of traveling in Europe and looking at picture-galleries. In educational circles the word 'discipline' is thrown at you on all occasions. It is the answer given to all educational inquiries; but its meaning to most minds is not clear. It generally stands for memorizing the rules of Latin prosody and committing the names of the Greek divinities. Another false notion which we absorb with our instruction is that all knowledge comes from books — that knowledge originates in books. The existence of this belief may be denied, because a second thought shows its absurdity; but the fallacy has taken possession of the mind of most students of books and controls their practical life. Knowledge is sought by them in books, and in books alone. The man educated only in books does not know how to find a truth except by means of a book. It is a fallacy to think that the best education is an education to interpret books, and not an education to interpret nature."

Solar Storms and Sun-Spots. — Whatever may be said in the matter of terrestrial weather-prediction, astronomers have learned to foretell with considerable correctness the occurrence of the mighty solar storms which produce what are called sun-spots; that is, they can tell what years will be characterized by many sun-storms and what years by few, for ten or twelve years in advance. The great sun-spots which were seen in the later months of 1882 were predicted at least twelve years before; and astronomy is far better assured that in the years 1893 and 1894 there will be many sun-spots than meteorologists are that any given month in the future of the present year will be of the normal character. But though the periodicity of the spots seems to be established, the reason of it is still wholly unknown. We have learned, from the observations of Professor Langley and the story told by the spectroscope, that so much of the light of the body of the sun is absorbed by its atmosphere that its color is changed from the real bluish violet to the yellowish white that we see; that the vapors in that atmosphere are largely metallic, and the rains on the sun are rains of metallic drops; that its storms rage over regions as large as the whole surface of the earth, and travel with a velocity compared with which the swiftest atmospheric movements on the earth are as rest; and that its constant emission of light and heat represents the equivalent of a consumption of fuel so far beyond what man can conceive that figures can give no idea of it. A connection seems to be fairly established between solar storms and magnetic disturbances on the earth. Yet there are storms, revealed by the protuberances on the edge of the solar disk, that are not felt on the earth; but this is because they rage on a part of the sun not turned toward the earth, and spend their effects in other portions of space. Whenever the face of the sun turned toward the earth has shown evidence of perturbation, our planet has responded quickly enough—quite as quickly as it responds to the rays of solar light. It seems clear, also, that the temperature of the earth as a whole is affected by the absence or presence of many spots on the sun's surface. But that there is any connection between the rain and wind cycles, the periods of famine and financial crisis, the recurrence of disasters and shipwrecks, bad vine-years, etc., as some have assumed to infer, has not yet been established; and the observations on these points are so contradictory as to have no value.

Microbes in Bricks.—Director Parize, of the agricultural station at Morlaix, France, has discovered that the crumbling of soft bricks and other earthen articles, which has been ascribed wholly to the action of moisture, is largely promoted, if it is not caused, by the growth of microbes. His attention was called to the fact in examining some mucedines which had grown upon a brick partition in a close, moist place, when he remarked some swellings or blisters in the plaster, from which a fine, red dust escaped when it was broken. Nothing but the brick-dust could be seen with the ordinary magnifier, but the application of a microscope of five hundred diameters revealed hosts of living microscopic organisms. Among them were micrococci, one-celled algæ and their spores, amibes, and ciliæ, moving with extreme rapidity, and some of the organisms in the process of budding. Deductions and lessons of considerable value and of quite wide extension may follow from this discovery.

Prevention of Floods in Mountain-Valleys.—Herr Carl Sonklar, of Innspruck, has published a paper on the means of preventing the floods to which the valleys of the Tyrolese Alps are subject. The remedy he proposes consists chiefly in the restoration and preservation of the forests that formerly clothed the mountains; and he suggests a set of very minute regulations and practical measures to promote that end, which, as well as all that is done about the forests, by private owners as well as by the public and the communes, are to be closely watched by the Government. To the plantation and cultivation of trees he would add barriers or dams accross the ravines, to detain the water of the freshets temporarily so that the washed-down mineral matter and gravel shall settle there and not be carried into the cultivated valleys below.

Storage-Batteries in Electric Lighting.—The composing-room of the Aberdeen (Scotland) "Journal" is lighted with perfect satisfaction by means of incandescent lamps supplied by accumulators. The electricity is stored by one of the engines used for the printing machinery during the intervals between issuing the different editions of the daily paper; and the accumulators, so charged, keep the lamps burning brightly all night, without needing to be replenished. Illumination through accumulators is wholly free from the unsteadiness which is complained of in using lights directly dependent on machinery, and is free from the risk of a sudden excess in the current destroying the carbon-filament of the lamp. The accumulators recommend themselves, moreover, as possessing "the enormous advantage of only yielding up the quantity of electricity actually consumed by the lamps alight at the moment, whereas, when the lighting is done directly from a dynamo, if part of the lamps are put out, an equivalent resistance must be inserted in order to prevent the breakage of the remaining lamps."

NOTES.

At the recent annual dinner of the Yale alumni resident in Boston and vicinity, opinions in regard to the classics, of the same tenor as those with which the Yale students have been so sedulously dosed all winter, were expressed by several speakers, including General F. A. Walker, President of the Massachusetts Institute of Technology. But we learn, from the report in the "Boston Transcript," that there was one dissenting voice: "Mr. Starr H. Nichols, of New York, of the class of '54, spoke next. He criticised the training of the colleges in the classics and mathematics as not developing the judgment of the students. They live in a Greek and Roman atmosphere, and can not distinguish between the ideal and the practical. They should have something to make them athletes in the business of life. Men should come out from college not feeling like strangers and pilgrims in the world, but at home. Classic learning does everything for a man except one thing, but that is the greatest thing of all, which is, to maintain one's self like a man in the world."

M. Nordenskiöld reports that he noticed that the snow falling in Stockholm toward the end of December was soiled with a black dust. Analyzing the dust, he found that it contained considerable carbonaceous matter, which burned with a flame, and left a residue containing oxide of iron, silica, phosphorus, and cobalt. He regards the observation as confirmatory of his theory of a regular accession of cosmic dust to the earth.

Dr. George Englemann, a distinguished American botanist, died February 4th, in St. Louis, Missouri, where he had lived since 1835. He was for many years a successful and honored physician in St. Louis, but was best known—to the whole world—by his scientific achievements. He was born and schooled in Germany, and, removing to Belleville, Illinois, began his botanical work by publishing a monograph in Latin on the habits of a creeper on the hazel-bush. This at once attracted attention in his native land. He made several excursions with Dr. Asa Gray through the West. He was especially well informed on the cactus; and was largely influential in introducing the present method of classification of plants, based on microscopical examinations and investigations.

Dr. Edward Davy, who is now living in Australia at the age of seventy-seven years, appears to have anticipated all other claimants in suggesting the use of electricity for telegraphing. He published a paper on the subject in the "Mechanics' Magazine" in 1838; but there has recently been found, among his old manuscripts, an outline, dated in 1836, "of a new plan of telegraphic communication, by which intelligence may be conveyed with precision to unlimited distances in an instant of time, independent of fog and darkness." His first idea was to use static electricity, but he afterward adopted electro-magnetism, with deflections of the galvanometer. He used half as many wires as there are letters of the alphabet, making each wire, according as it worked a deflection to the right or to the left, answer for two letters.

Dr. Henry Macauley, of Belfast, Ireland, has suggested a plan for making the sun do direct service in cooling the air it heats, by using Mochot's solar-engine to pump cold air into dwellings, factories, etc. The drawback to his proposition is, that it depends upon ice to furnish the cooling influence, and this is not always on hand in tropical countries.

The great collection of fungi of Baron Felix von Thümen, of Vienna, was offered for sale a few months ago. It includes, in two hundred and twenty-one portfolios, more than thirty-five thousand specimens, representing one thousand genera, and fifteen thousand species and varieties, besides forty portfolios more recently acquired, containing fifteen thousand specimens of five thousand species and varieties, still unarranged. It furnished the material by the aid of which Dr. A. Minks's "Symbolæ Licheno-mycologicæ" was prepared.

Dr. Crosskey writes: "It is a wonderful thing to see the power of experimental science over the roughest lads. My own belief is that, in our young blackguards, we have a most amazing reserve power of scientific research; they are alive in every sense, and I have watched them at the science-lessons as keenly interested as if they were up to mischief in the streets."

It appears from a recent observation by Dr. Fleitman, that much less time than has been generally supposed is required for the formation of mineral veins. About two years ago, Dr. Fleitman filled up a ditch with common clay containing iron. Having had occasion to dig out the ditch anew, he was surprised to find that the character of the clay had been changed, and it had turned white. It was also permeated in various directions by cracks from a twenty-fifth to a sixth of an inch in section, which were filled with compact iron pyrites.

The death is announced of François Lenormant, one of the most distinguished scholars of the age in Oriental archæology. While he was at home in all branches of this subject, his work was more especially concerned with the Asiatic civilizations and the cuneiform inscriptions. His book on the "Beginnings of History" is a real storehouse of the results of the latest researches in this field, and is one of the most satisfactory compendiums of extremely ancient history. He was a devoted Roman Catholic, but did not shrink from the boldest conclusions which the students of the ancient records have reached; and he had no trouble in satisfying himself of their complete harmony with the biblical record and Jewish traditions rightly interpreted.

Mr. D. E. Salmon has shown, in a communication to "Science," that the micrococcus which is the cause of typhoid in hogs was discovered by Dr. Detmers of our Department of Agriculture, and was described by him, with additional knowledge each time, in the reports giving the results of his investigations from 1878 to 1882. Mr. Salmon, co-operating also with the Department of Agriculture, demonstrated that this micrococcus exists in the blood during the life of the animal, that it can be cultivated in flasks, and that the sixth successive cultivation is still competent to produce the disease. Thuillier, working with Pasteur, made an independent discovery of the same organism, without knowledge of the American work, in 1882. Before either of these discoveries, Klein, in 1876, encountered the organism, but failed to connect it with the virus of the disease, and afterward assigned the malady to a different schizophyte.

Dr. D. J. Macgowan, in his "Notes on Earthquakes in China for 1882," mentions three classes of earthquakes as distinguishable in that country—insular, littoral, and interior. Earthquakes in Formosa and Hainan are frequently felt on the mainland to the coast-mountains, but not above tide-water, except in the basin of the lower Yangtse. They are sometimes accompanied by marine disturbances, and are often followed by increased action in the *solfatara* and complaints of *malaise*, consequent, doubtless, upon the emission of hydrosulphuric gases. Of the three principal interior seismic foci, Szechuen, Shansi, and Kansuh, the two former are situated far from volcanoes, and their shocks are often reported as continuous for considerable periods.

A movement has been started in Bradford, England, to test the legality of the imposition of home-lessons on the children in the elementary schools.

ARNOLD HENRY GUYOT.

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THE SINS OF LEGISLATORS.

By HERBERT SPENCER.

II.

THE reply to all this will doubtless be that nothing better than guidance by "collective wisdom" can be had—that the select men of the nation, led by a reselected few, bring their best powers, enlightened by all the knowledge of the time, to bear on the matters before them. "What more would you have?" will be the question asked by most.

My answer is that this best knowledge of the time with which legislators are said to come prepared for their duties is a knowledge of which the greater part is obviously irrelevant, and that they are blameworthy for not seeing what is the relevant knowledge. No amount of the linguistic acquirements by which many of them are distinguished will help their judgments in the least; nor will they be appreciably helped by the literatures these acquirements open to them. Neither the history of Thucydides, nor the biographies of Plutarch, nor the dialogues of Plato, will in any considerable degree prepare them for judging how this or that measure will operate on social life. Not even Aristotle's "Politics" will give them much help in judging how acts of Parliament are likely to work. They may ponder on the doings of all the great men by whom, according to the Carlylean theory, society is framed, and they may spend years over those accounts of international conflicts, and treacheries, and intrigues, and treaties, which fill historical works, without being much nearer understanding the how and the why of social structures and actions, and the ways in which laws affect them. Nor does such information as is picked up in the factory, on 'change, or in the justice-room, go far toward the required preparation.

That which is really needed is a systematic study of natural causation as displayed among human beings socially aggregated. Though a distinct consciousness of causation is the last trait which intellectual progress brings—though with the savage a simple mechanical cause is not conceived as such—though even among the Greeks the flight of a spear was thought of as guided by a god—though, from their times down almost to our own, epidemics have been habitually regarded as of supernatural origin—and though among social phenomena, the most complex of all, causal relations may be expected to continue longest unrecognized; yet, in our days, the existence of such causal relations has become clear enough to force on all who think the inference that before meddling with them they should be diligently studied. The mere facts, now familiar, that there is a connection between the numbers of births, deaths, and marriages, and the price of corn, and that in the same society during the same generation the ratio of crime to population maintains a kindred regularity, should be sufficient to make all see that human desires, using as guide such intellect as is joined with them, act with approximate uniformity. It should be inferred that, among social causes, those initiated by legislation, similarly operating with an average regularity, must not only change men's actions, but, by consequence, change their natures—probably in ways not intended. There should be a recognition of the fact that social causation, more than all other causation, is a fructifying causation; and it should be seen that indirect and remote effects are no less inevitable than proximate effects. I do not mean that there is denial of these statements and inferences. But there are beliefs and beliefs—some which are held but nominally, some which influence conduct in small degrees, some which sway it irresistibly under all circumstances; and unhappily the beliefs of law-makers respecting causation in social affairs are of the superficial sort. Let us look at some of the truths which they tacitly admit, but which are scarcely at all taken account of in legislation.

There is the indisputable fact that each human being is in a certain degree modifiable both physically and mentally. Every theory of education, every discipline, from that of the arithmetician to that of the prize-fighter, every proposed reward for virtue or punishment for vice, implies the belief, embodied in sundry proverbs, that the use or disuse of each faculty, bodily or mental, is followed by an adaptive change in it—loss of power or gain of power according to demand.

There is the fact, also in its broader manifestations universally recognized, that modifications of nature, in one way or other produced, are inheritable. No one denies that by the accumulation of small changes, generation after generation, constitution fits itself to conditions ; so that a climate is wholesome to the adapted race which is fatal to other races. No one denies that peoples who belong to the same original stock but have spread into different habitats where they have led different lives have acquired in course of time different aptitudes and different tendencies. No one denies that under new conditions new national characters are even now being molded, as witness the Americans. And if no one denies a process of adaptation everywhere and always going on, it is a manifest implication that adaptive modifications must be set up by every change of social conditions.

To which there comes the undeniable corollary that every law which serves to alter men's modes of action—compelling, or restraining, or aiding, in new ways—so affects them as to cause in course of time an adjusted nature. Beyond any immediate effect wrought, there is the remote effect, wholly ignored by most—a remolding of the average character : a remolding which may be of a desirable or an undesirable kind, but which in any case is the most important of the results to be considered.

Other general truths, which the citizen, and still more the legislator, ought to contemplate until they become wrought into his intellectual fabric, are disclosed when we ask how social activities are produced ; and when we recognize the obvious answer that they are the aggregate results of the desires of individuals who are severally seeking satisfactions, and ordinarily pursuing the ways which, with their preexisting habits and thoughts, seem the easiest—following the lines of least resistance : the truths of political economy being so many sequences. It needs no proving that social structures and social actions must in some way or other be the outcome of human emotions guided by ideas—either those of ancestors or those of living men. And that the right interpretation of social phenomena is to be found in the cooperation of these factors from generation to generation follows inevitably.

Such an interpretation soon brings us to the inference that, of the aggregate results of men's desires seeking their gratifications, those which have prompted their private activities and their spontaneous co-operations have done much more toward social development than those which have operated through governmental agencies. That abundant crops now grow where once only wild berries could be gathered is due to the pursuit of individual satisfactions through many centuries. The progress from wigwams to good houses has resulted from wishes to increase personal welfare ; and towns have arisen under the like promptings. Beginning with peddlers and with traffic at meetings on occasions of religious festivals, the trading organization, now so extensive and complex, has been produced entirely by men's efforts to achieve their private ends. Perpetually governments have thwarted and deranged the growth, but have in no way furthered it, save by partially discharging their proper function and maintaining social order. So, too, with those advances of knowledge and those improvements of appliances by which these structural changes and these increasing activities have been made possible. It is not to the state that we owe the multitudinous useful inventions from the plow to the telephone; it is not the state which made possible extended navigation by a developed astronomy; it is not the state which made the discoveries in physics, chemistry, and the rest, which guide modern manufacturers; it is not the state which devised the machinery for producing fabrics of every kind, for transferring men and things from place to place, and for ministering in a thousand ways to our comforts. The world-wide transactions going on in merchants' offices, the rush of traffic filling our streets, the retail distributing system which brings everything within easy reach and delivers the necessaries of life daily at our doors, are not of governmental origin. All these are the results of the spontaneous activities of citizens, separate or combined. Nay, to these spontaneous activities governments owe the very means of performing their duties. Divest the political machinery of all those aids which science and art have yielded it—leave it with those only which state-officials have invented—and its functions would cease. The very language in which its laws are registered and the orders of its agents daily given is an instrument not in the remotest degree due to the legislator, but is one which has unawares grown up during men's intercourse while pursuing their personal satisfactions.

And then a truth, to which the foregoing one introduces us, is that this spontaneously-formed social organization is so bound together that you can not act on one part without acting more or less on all parts. We see this unmistakably when a cotton-famine, first paralyzing certain manufacturing districts and then affecting the doings of wholesale and retail distributors throughout the kingdom, as well as the people they supply, goes on to affect the makers and distributors, as well as the wearers, of other fabrics—woolen, linen, etc. Or we see it when a rise in the price of coal, besides influencing domestic life everywhere, hinders the greater part of our industries, raises the prices of the commodities produced, alters the consumption of them, and changes the habits of consumers. What we see clearly in these marked cases happens in every case in sensible or in insensible ways. And, manifestly, acts of Parliament are among those factors which, beyond the effects directly produced, have countless other effects of multitudinous kinds. As I heard remarked by a distinguished professor, whose studies give ample means of judging, "When once you begin to interfere with the order of Nature there is no knowing where the results will end." And, if this is true of that sub-human order of Nature to which he referred, still more is it true of that order of Nature existing in the social arrangements produced by aggregated human beings.

And now, to carry home the conclusion that the legislator should bring to his business a vivid consciousness of these and other such broad truths concerning the human society with which he proposes to deal, let me present somewhat more fully one of them not yet mentioned.

The continued life of every higher species of creature depends on conformity, now to one, now to the other, of two radically-opposed principles. The early lives of its members and the adult lives of its members have to be dealt with in contrary ways. We will contemplate them in their natural order.

One of the most familiar facts is that animals of superior types, comparatively slow in reaching maturity, are enabled, when they have reached it, to give more aid to their offspring than animals of inferior types. The adults foster their young during periods more or less prolonged, while yet the young are unable to provide for themselves; and it is obvious that maintenance of the species can be secured only by a parental care adjusted to the need consequent on imperfection. It requires no proving that the blind, unfledged hedge-bird, or the young puppy even after it has acquired sight, would forthwith die if it had to keep itself warm and obtain its own food. The gratuitous parental aid must be great in proportion as the young one is of little worth, either to itself or to others; and it may diminish as fast as, by increasing development, the young one acquires worth, at first for self-sustentation, and by-and-by for sustentation of others. That is to say, during immaturity, benefits received must be inversely as the power or ability of the receiver. Clearly, if during this first part of life benefits were proportioned to merits, or rewards to deserts, the species would disappear in a generation.

From this *régime* of the family-group, let us turn to the *régime* of that larger group formed by the adult members of the species. Ask what happens when the new individual, acquiring complete use of its powers and ceasing to have parental aid, is left to itself. Now there comes into play a principle just the reverse of that above described. Throughout the rest of its life, each adult gets benefit in proportion to merit—reward in proportion to desert: merit and desert in each case being understood as ability to fulfill all the requirements of life—to get food, to secure shelter, to escape enemies. Placed in competition with members of its own species, and in antagonism with members of other species, it dwindles and gets killed off, or thrives and propagates, according as it is ill-endowed or well-endowed. Manifestly an opposite *régime*, could it be maintained, would, in course of time, be fatal to the species. If the benefits received by each member of it were proportionate to its inferiority—if, as a consequence, multiplication of the inferior was furthered and multiplication of the superior hindered, progressive degradation would result; and eventually the species, as a whole, would fail to hold its ground in presence of antagonistic species and competing species.

The broad fact, then, here to be noted, is that Nature's modes of treatment inside the family-group and outside the family-group are diametrically opposed to one another; and that the intrusion of either mode into the sphere of the other would be fatal to the species, either immediately or remotely.

Does any one think that the like does not hold of the human species? He can not deny that within the human family, as within any inferior family, it would be fatal to proportion benefit to merit. Can he assert that outside the family, among adults, there should not be proportioning of benefit to merit? Will he contend that no mischief will result if the lowly endowed are enabled to thrive and multiply as much as, or more than, the highly endowed? A society of men, standing toward other societies in relations of either antagonism or competition, may be considered as a species, or, more literally, as a variety of a species; and it must be true of it as of other species or varieties, that it will be unable to hold its own in the struggle with other societies, if it disadvantages its superior units that it may advantage its inferior units. Surely none can fail to see that were the principle of family life to be adopted and fully carried out in social life—were reward always great in proportion as desert was small—fatal results to the society would quickly follow; and, if so, then even a partial intrusion of the family *régime* into the *régime* of the state will be slowly followed by fatal results. Society in its corporate capacity can not, without immediate or remote disaster, interfere with the play of these opposed principles under which every species has reached such fitness for its mode of life as it possesses, and under which it maintains that fitness.

I say advisedly—society in its corporate capacity: not intending to exclude or condemn aid given to the inferior by the superior in their individual capacities. Though, when given so indiscriminately as to enable the inferior to multiply, such aid entails mischief; yet in the absence of aid given by society, individual aid, more generally demanded than now, and associated with a greater sense of responsibility, would, on the average, be given with the effect of fostering the unfortunate worthy rather than the innately unworthy: there being always, too, the concomitant social benefit arising from culture of the sympathies. But all this may be admitted while asserting that the radical distinction between family-ethics and state-ethics must be maintained; and that, while generosity must be the essential principle of the one, justice must be the essential principle of the other—a rigorous maintenance of those normal relations among citizens under which each gets in return for his labor, skilled or unskilled, bodily or mental, as much as is proved to be its value by the demand for it: such return, therefore, as will enable him to thrive and rear offspring in proportion to the superiorities which make him valuable to himself and others.

And yet, notwithstanding the conspicuousness of these truths, which should strike every one who leaves his lexicons, and his law-deeds, and his ledgers, and looks abroad into that natural order of things under which we exist, and to which we must conform, there is continual advocacy of paternal government. The intrusion of family-ethics into the ethics of the state, instead of being regarded as socially injurious, is more and more demanded as the only efficient means to social benefit. So far has this delusion now gone, that it vitiates the beliefs of those who might, more than all others, be thought safe from it. In the essay to which the Cobden Club awarded its prize in 1880, there occurs the assertion that "the truth of free trade is clouded over by the *laissez-faire* fallacy"; and we are told that "we need a great deal more of paternal government—that bugbear of the old economists." *

Vitally important as is the truth above insisted upon, since acceptance or rejection of it affects the entire fabric of political conclusions formed, I may be excused if I re-emphasize it by here quoting certain passages contained in a work I published in 1850: premising only that the reader must not hold me committed to such teleological implications as they contain. After describing "that state of universal warfare maintained throughout the lower creation," and showing that an average of benefit results from it, I have continued thus:

> Note, further, that their carnivorous enemies not only remove from herbivorous herds individuals past their prime, but also weed out the sickly, the malformed, and the least fleet or powerful. By the aid of which purifying process, as well as by the fighting, so universal in the pairing-season, all vitiation of race through the multiplication of its inferior samples is prevented, and the maintenance of a constitution completely adapted to surrounding conditions, and therefore most productive of happiness, is insured.
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> The development of the higher creation is a progress toward a form of being capable of happiness undiminished by these drawbacks. It is in the human race that the consummation is to be accomplished. Civilization is the last stage of its accomplishment. And the ideal man is the man in whom all the conditions of that accomplishment are fulfilled. Meanwhile, the well-being of existing humanity and the unfolding of it into this ultimate perfection are both secured by that same beneficent though severe discipline to which the animate creation at large is subject—a discipline which is pitiless in the working out of good, a felicity-pursuing law which never swerves for the avoidance of partial and temporary suffering. The poverty of the incapable, the distresses that come upon the imprudent, the starvation of the idle, and those shoulderings aside of the weak by the strong, which leave so many "in shallows and in miseries," are the decrees of a large, far-seeing benevolence. . . .
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> To become fit for the social state, man has not only to lose his savageness, but he has to acquire the capacities needful for civilized life. Power of appli-

* "On the Value of Political Economy to Mankind," by A. N. Cumming, pp. 47, 48.

cation must be developed; such modification of the intellect as shall qualify it for its new tasks must take place; and, above all, there must be gained the ability to sacrifice a small immediate gratification for a future great one. The state of transition will, of course, be an unhappy state. Misery inevitably results from incongruity between constitutions and conditions. All these evils which afflict us, and seem to the uninitiated the obvious consequences of this or that removable cause, are unavoidable attendants on the adaptation now in progress. Humanity is being pressed against the inexorable necessities of its new position—is being molded into harmony with them, and has to bear the resulting unhappiness as best it can. The process *must* be undergone, and the sufferings *must* be endured. No power on earth, no cunningly-devised laws of statesmen, no world-rectifying schemes of the humane, no communist panaceas, no reforms that men ever did broach or ever will broach, can diminish them one jot. Intensified they may be, and are; and, in preventing their intensification, the philanthropic will find ample scope for exertion. But there is bound up with the change a *normal* amount of suffering, which can not be lessened without altering the very laws of life. . . .

Of course, in so far as the severity of this process is mitigated by the spontaneous sympathy of men for each other, it is proper that it should be mitigated; albeit there is unquestionable harm done when sympathy is shown, without any regard to ultimate results. But the drawbacks hence arising are nothing like commensurate with the benefits otherwise conferred. Only when this sympathy prompts to a breach of equity—only when it originates an interference forbidden by the law of equal freedom—only when, by so doing, it suspends in some particular department of life the relationship between constitution and conditions, does it work pure evil. Then, however, it defeats its own end. Instead of diminishing suffering, it eventually increases it. It favors the multiplication of those worst fitted for existence, and, by consequence, hinders the multiplication of those best fitted for existence—leaving, as it does, less room for them. It tends to fill the world with those to whom life will bring most pain, and tends to keep out of it those to whom life will bring most pleasure. It inflicts positive misery, and prevents positive happiness.—"Social Statics," pp. 322–325 and pp. 380, 381 (edition of 1851).

The lapse of a third of a century since these passages were published has brought me no reason for retreating from the position taken up in them. Contrariwise, it has brought a vast amount of evidence strengthening that position. The beneficial results of the survival of the fittest prove to be immeasurably greater than those above indicated. The process of "natural selection," as Mr. Darwin called it, co-operating with a tendency to variations and to inheritance of variations, he has shown to be a chief cause (though not, I believe, the sole cause) of that evolution through which all living things, beginning with the lowest and diverging and rediverging as they evolved, have reached their present degrees of organization and adaptation to their modes of life. So familiar has this truth become that some apology seems needed for naming it. And yet, strange to say, now that this truth is recognized by most cultivated people—now that the beneficent working of the survival of the fittest has been so impressed on them that, much more than people in past times, they might be expected to hesitate before neutralizing its action—now more than ever before in the history of the world are they doing all they can to further survival of the unfittest!

But the postulate that men are rational beings continually leads one to draw inferences which prove to be extremely wide of the mark.*

"Yes, truly; your principle is derived from the lives of brutes, and is a brutal principle. You will not persuade me that men are to be under the discipline which animals are under. I care nothing for your natural-history arguments. My conscience shows me that the feeble and the suffering must be helped; and, if selfish people won't help them, they must be forced by law to help them. Don't tell me that the milk of human kindness is to be reserved for the relations between individuals, and that governments must be the administrators of nothing but hard justice. Every man with sympathy in him must feel that hunger and pain and squalor must be prevented, and that, if private agencies do not suffice, then public agencies must be established."

Such is the kind of response which I expect to be made by nine out of ten. In some of them it will doubtless result from a fellow-feeling so acute that they can not contemplate human misery without an impatience which excludes all thought of remote results. Concerning the susceptibilities of the rest, we may, however, be somewhat skeptical. Persons, who, now in this case and now in that, are angry if, to maintain our supposed national "interests" or national "*prestige*," those in authority do not promptly send out some thousands of men to be partially destroyed while destroying other thousands of men whose intentions we suspect, or whose institutions we think dangerous to us, or whose territory our colonists want, can not after all be so tender in feeling that contemplating the hardships of the poor is intolerable to them. Little admiration need be felt for the professed sympathies of men who urge on a policy which breaks up progressing societies, and who then look on with cynical indifference at the weltering confusion left behind, with all its entailed suffering and death. Those who, when a people asserting their independence successfully

* The saying of Emerson, that most people can understand a principle only when its light falls on a fact, induces me here to cite a fact which may carry home the above principle to those on whom in its abstract form it may produce no effect. It rarely happens that the amount of evil caused by fostering the vicious and the good-for-nothing can be estimated. But in America, at a meeting of the State Charities Aid Association, held on December 18, 1874, a startling instance was given in detail by Dr. Harris. It was furnished by a county on the upper Hudson, remarkable for the ratio of crime and poverty to population. Generations ago there had existed a certain "gutter-child," as she would be here called, known as "Margaret," who proved to be the prolific mother of a prolific race. Besides great numbers of idiots, imbeciles, drunkards, lunatics, paupers, and prostitutes, "the county records show two hundred of her descendants who have been criminals." Was it kindness or cruelty which, generation after generation, enabled these to multiply and become an increasing curse to the society around them?

resisted us, were angry because British "honor" was not maintained by fighting to avenge a defeat, at the cost of more mortality and misery to our own soldiers and their antagonists, can not have so much "enthusiasm of humanity" as protests like that indicated above would lead one to expect. Indeed, along with this quick sympathy which they profess will not let them look with patience on the pains of "the battle of life" as it quietly goes on around, they appear to have a callousness which not only tolerates but enjoys contemplating the pains of battles of the literal kind; as one sees in the demand for illustrated papers containing scenes of carnage, and in the greediness with which detailed accounts of bloody engagements are read. We may reasonably have our doubts about men who are so sensitive that they can not bear the thought of hardships borne, mostly by the idle and improvident, and who, nevertheless, have demanded twenty-nine editions of "The Fifteen Decisive Battles of the World," in which they may revel in accounts of slaughter. Nay, even still more remarkable is the contrast between the professed tender-heartedness and the actual hard-heartedness of those who would reverse the normal course of things that immediate miseries may be prevented, even at the cost of greater miseries hereafter produced. For on other occasions you may hear them, with utter disregard of bloodshed and death, contend that in the interests of humanity at large it is well that the inferior races should be exterminated and their places occupied by the superior races. So that, marvelous to relate, though they can not bear to think of the evils accompanying the struggle for existence as it is carried on without violence among individuals in their own society, they can not only tolerate but can applaud such evils in their intense and wholesale forms when inflicted by fire and sword on entire communities. Not worthy of much respect, then, as it seems to me, is this generous consideration of the inferior at home which is accompanied by unscrupulous sacrifice of the inferior abroad.

Still less respectable appears this extreme concern for those of our own blood which goes along with utter unconcern for those of other blood, when we observe its methods. Did it prompt personal effort to relieve the suffering, it would rightly receive approving recognition. Were the many who express this cheap pity like the few who patiently, week after week, and year after year, devote large parts of their time to helping and encouraging, and occasionally amusing, those who, in some cases by ill-fortune and in other cases by incapacity or misconduct, are brought to lives of hardship, they would be worthy of unqualified admiration. The more there are of men and women who help the poor to help themselves—the more there are of those whose sympathy is exhibited directly and not by proxy, the more we may rejoice. But the immense majority of the persons who wish to mitigate by law the miseries of the unsuccessful and the reckless propose to do this in small measure at their own cost and mainly at the cost of others—

sometimes with their assent but mostly without. More than this is true ; for those who are to be forced to do so much for the miserable often equally or more require something doing for them. The deserving poor are among those who are burdened to pay the costs of caring for the undeserving poor. As under the old poor-law the diligent and provident laborer had to pay that the good-for-nothings might not suffer, until frequently under this extra burden he broke down and himself took refuge in the workhouse—as at present it is admitted that the total rates levied in large towns for all public purposes have now reached such a height that they "can not be exceeded without inflicting great hardship on the small shopkeepers and artisans, who already find it difficult enough to keep themselves free from the pauper taint" ;* so in all cases the policy is one which intensifies the pains of those most deserving of pity, that the pains of those least deserving of pity may be mitigated. In short, men who are so sympathetic that they can not allow the struggle for existence to bring on the unworthy the sufferings consequent on their incapacity or misconduct, are so unsympathetic that they can, with equanimity, make the struggle for existence harder for the worthy, and inflict on them and their children artificial evils in addition to the natural evils they have to bear!

And here we are brought round to our original topic—the sins of legislators. Here there comes clearly before us the commonest of the transgressions which rulers commit—a transgression so common, and so sanctified by custom, that no one imagines it to be a transgression. Here we see that, as indicated at the outset, Government, begotten of aggression and by aggression, ever continues to betray its original nature by its aggressiveness ; and that even what on its nearer face seems beneficence only, shows, on its remoter face, not a little maleficence—kindness at the cost of cruelty. For is it not cruel to increase the sufferings of the better that the sufferers of the worse may be decreased?

It is, indeed, marvelous how readily we let ourselves be deceived by words and phrases which suggest one aspect of the facts while leaving the opposite aspect unsuggested. A good illustration of this, and one germane to the immediate question, is seen in the use of the words "protection" and "protectionist" by the antagonists of free trade, and in the tacit admission of its propriety by free-traders. While the one party has habitually ignored, the other party has habitually failed to emphasize, the truth that this so-called protection always involves aggression ; and that the name aggressionist ought to be substituted for the name protectionist. For nothing can be more certain than that, if to maintain A's profit B is forbidden to buy of C, or is fined to the extent of the duty if he buys of C, B is aggressed

* Mr. Chamberlain in "Fortnightly Review," December, 1883, p. 772.

upon that A may be "protected." Nay, aggressionists would much more truly describe the anti-free-traders than the euphemistic title "protectionists"; since, that one producer may gain, ten consumers are fleeced.

Now, just the like confusion of ideas, caused by looking at one face only of the transaction, may be traced throughout all the legislation which forcibly takes the property of this man for the purpose of giving gratis benefits to that man. Habitually when one of the numerous measures thus characterized is discussed, the dominant thought is concerning the pitiable Jones who is to be protected against some evil, while no thought is given to the hard-working Brown who is aggressed upon, often much more to be pitied. Money is exacted (either directly or through raised rent) from the huckster who only by extreme pinching can pay her way, from the mason thrown out of work by a strike, from the mechanic whose savings are melting away during an illness, from the widow who washes or sews from dawn to dark to feed her fatherless little ones; and all that the dissolute may be saved from hunger, that the children of less impoverished neighbors may be educated, and that various people, mostly better off, may read newspapers and novels for nothing! The error of nomenclature is, in one respect, more misleading than that which, as we see, allows aggressionists to be called protectionists; for, as just shown, protection of the vicious poor involves aggression on the virtuous poor. Doubtless it is true that the greater part of the money exacted comes from those who are relatively well-off. But this is no consolation to the ill-off from whom the rest is exacted. Nay, if the comparison be made between the pressures borne by the two classes respectively, it becomes manifest that the case is even worse than at first appears; for, while to the well-off the exaction means loss of luxuries, to the ill-off it means loss of necessaries.

And now see the Nemesis which is threatening to follow this chronic sin of legislators. They and their class, in common with all owners of property, are in danger of suffering from a sweeping application of that general principle practically asserted by each of these confiscating acts of Parliament. For what is the tacit assumption on which such acts proceed? It is the assumption that no man has any claim to his property, not even to that which he has earned by the sweat of his brow, save by permission of the community; and that the community may cancel the claim to any extent it thinks fit. No defense can be made for this appropriation of A's possessions for the benefit of B, save one which sets out with the postulate that society as a whole has an absolute right over the possessions of each member. And now this doctrine, which has been tacitly assumed, is being openly proclaimed. Mr. George and his friends, Mr. Hyndman and his supporters, are pushing the theory to its logical issue. They have been instructed by examples, yearly increasing in number, that the individual has no rights but what the community may equitably override; and they are now saying, "It shall go hard but we will better the instruction," and override individual rights altogether.

Legislative misdeeds of the classes above indicated are in large measure explained, and reprobation of them mitigated, when we look at the matter from afar off. They have their root in the error that society is a manufacture; whereas it is a growth. Neither the culture of past times nor the culture of the present time has given to any considerable number of people a scientific conception of a society—a conception of it as having a natural structure in which all its institutions, governmental, religious, industrial, commercial, etc., etc., are interdependently bound—a structure which is in a sense organic. Or if such a conception is nominally admitted, it is not believed in such way as to be operative on conduct. Contrariwise, incorporated humanity is very commonly thought of as though it were like so much dough which the cook can mold at will into pie-crust, or puff, or tartlet. The communist shows us unmistakably that he thinks of the body politic as admitting of being shaped thus or thus at will; and the tacit implication of many acts of Parliament is that aggregated men, twisted into this or that arrangement, will remain as intended.

It may indeed be said that, even irrespective of this erroneous conception of a society as a plastic mass instead of as an organized body, facts forced on his attention hour by hour should make every one skeptical as to the success of this or that proposed way of changing a people's actions. Alike to the citizen and to the legislator, home experiences daily supply proofs that the conduct of human beings balks calculation. He has given up the thought of managing his wife, and lets her manage him. Children on whom he has tried now reprimand, now punishment, now suasion, now reward, do not respond satisfactorily to any method; and no expostulation prevents their mother from treating them in ways he thinks mischievous. So, too, his dealings with his servants, whether by reasoning or by scolding, rarely succeed for long: the falling short of attention, or punctuality, or cleanliness, or sobriety, leads to constant changes. Yet, difficult as he finds it to deal with humanity in detail, he is confident of his ability to deal with embodied humanity. Citizens, not one-thousandth of whom he knows, not one-hundredth of whom he ever saw, and the great mass of whom belong to classes having habits and modes of thought of which he has but dim notions, he has no doubt will act in certain ways he foresees, and fulfill ends he wishes. Is there not a marvelous incongruity between premises and conclusion?

One might have expected that whether they observed the implications of these domestic failures, or whether they contemplated in every newspaper the indications of a social life too vast, too varied, too involved, to be even vaguely pictured in thought, men would have entered on the business of law-making with the greatest hesitation. Yet in this more than in anything else do they show a confident readiness. Nowhere is there so astounding a contrast between the difficulty of the task and the unpreparedness of those who undertake it. Surely among monstrous beliefs one of the most monstrous is that, while for a mean handicraft, such as shoe-making, a long apprenticeship is needful, the sole thing which needs no apprenticeship is making a nation's laws!

Summing up the results of the discussion, may we not reasonably say that there lie before the legislator several open secrets, which yet are so open that they ought not to remain secrets to one who undertakes the vast and terrible responsibility of dealing with millions upon millions of human beings by measures which, if they do not conduce to their happiness, will increase their miseries and accelerate their deaths?

There is first of all the undeniable truth, conspicuous and yet absolutely ignored, that there are no phenomena which a society presents but what have their origins in the phenomena of individual human life, which again have their roots in vital phenomena at large. And there is the inevitable implication that unless these vital phenomena, bodily and mental, are chaotic in their relations (a supposition excluded by the very maintenance of life) the resulting phenomena can not be wholly chaotic: there must be some kind of order in the phenomena which grow out of them when associated human beings have to co-operate. Evidently, then, when one who has not studied such resulting phenomena of social order undertakes to regulate society he is pretty certain to work mischiefs.

In the second place, apart from *a priori* reasoning, this conclusion should be forced on the legislator by comparisons of societies. It ought to be sufficiently manifest that, before meddling with the details of social organization, inquiry should be made whether social organization has a natural history; and that, to answer this inquiry, it would be well, setting out with the simplest societies, to see in what respects social structures agree. Such comparative sociology, pursued to a very small extent, shows a substantial uniformity of genesis. The habitual existence of chieftainship, and the establishment of chiefly authority by war; the rise everywhere of the medicine-man and priest; the presence of a cult having in all places the same fundamental traits; the traces of division of labor, early displayed, which gradually become more marked; and the various complications, political, ecclesiastical, industrial, which arise as groups are compounded and recompounded by war—quickly prove to any who compares them that, apart from all their special differences, societies have general resemblances in their modes of origin and development. They present traits of structure showing that social organization has laws which override individual wills; and laws the disregard of which must be fraught with disaster.

And then, in the third place, there is that mass of guiding information yielded by the records of law-making in our own country and in other countries, which still more obviously demands attention. Here and elsewhere attempts of multitudinous kinds, made by kings and statesmen, have failed to do the good intended and have worked unexpected evils. Century after century new measures like the old ones, and other measures akin in principle, have again disappointed hopes and again brought disaster. And yet it is thought neither by electors nor by those they elect that there is any need for systematic study of that legislation which in by-gone ages went on working the ill-being of the people when it tried to achieve their well-being. Surely there can be no fitness for legislative functions without wide knowledge of those legislative experiences which the past has bequeathed.

Reverting, then, to the analogy drawn at the outset, we must say that the legislator is morally blameless or morally blameworthy according as he has or has not acquainted himself with these several classes of facts. A physician who, after years of study, has gained a competent knowledge of physiology, pathology and therapeutics, is not held criminally responsible if a man dies under his treatment; he has prepared himself as well as he can, and has acted to the best of his judgment. Similarly the legislator whose measures produce evil instead of good, notwithstanding the extensive and methodic inquiries which helped him to decide, can not be held to have committed more than an error of reasoning. Contrariwise, the legislator who is wholly or in great measure uninformed concerning these masses of facts which he must examine before his opinion on a proposed law can be of any value, and who nevertheless helps to pass that law, can no more be absolved if misery and mortality result, than the journeyman druggist can be absolved when death is caused by the medicine he ignorantly prescribes.

MODES OF REPRODUCTION IN PLANTS.

By BYRON D. HALSTED, Sc. D.

THE sexual generation of a plant is that stage in its life-history which bears the male and female organs, while the asexual generations are those having no sexuality manifest. The two kinds of generations frequently follow each other in alternate order, when there is what is known as an alternation of generations.

Growing plants continue to increase in size in a well-defined manner for a time, and then a single cell, or a small group of cells, begins on a new line of development. This new growth finally becomes detached from the parent-plant. The offspring may, or may not, be like the parent. Plants which result from similar cells developed in the same manner belong to the same generation. If the original reproductive cells grow into plants without any union with other cells, these plants are asexually produced. If the union of the contents of two or more cells is necessary for further development, there results a sexual product.

It is the purpose of this paper to trace the relative size of the two generations above described, in a number of the higher orders of plants. In doing this, the fact of the alternation will be developed. The series of orders will begin with the humble *Hepaticœ*, and end with the most highly developed of flowering plants. The *Hepaticœ*, or liverworts, are small, flowerless plants of very simple structure, which grow for the most part in moist places upon the bark of trees, surface of long-exposed rocks, earth, etc. One of the leading genera is *Marchantia*, species of which abound on the earth of flower-pots in greenhouses and elsewhere. The leaf-like expansion or thallus is the sexual generation, and bears the male and female organs in depressions of the surface. The male parts, called antheridia, produce spermatozoids, which are spiral, slender bodies, provided with two motile hairs or cilia, as locomotive appendages. The female organs (archegonia) are at first single cells, which by division form flask-like structures, the lower cell of which is the female germ-cell. When this germ is fertilized by the antherozoids, which enter at the neck of the "flask," it undergoes a development, varying somewhat in the different orders, but essentially a sporangium or spore-case is produced, in which are very many spores and slender spiral threads arranged in rows. This sporangium is the second and asexual generation of the liverwort. The complexity of the structure of

Fig. 1.

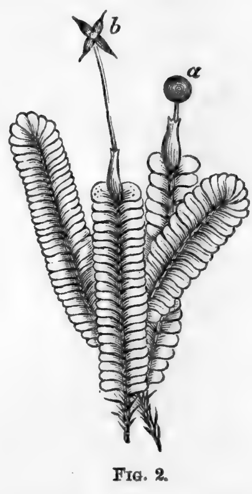

Fig. 2.

the first or leaf-like generation and of the sexual organs and sporangia increases in the hepaticæ group in passing from the lower to the higher forms. In the highest group there are stems with leaves arranged in rows, and the sporangia are raised on long stalks. Fig. 1 shows at *t* a portion of *Marchantia polymorphia*, with an upright receptacle, *h*, bearing the male organs. In Fig. 2 is seen a stem of *Plagiochila asplenioides;* *a* is a ripe sporangium, and *b* one that has opened.

In the mosses, the next class in the upward scale of plant-life, the spore germinates by producing a fine green thread, which branches and forms a plant much resembling many of the filamentous fresh-water algæ. In the order *Sphagnaceæ* this "alga form" is a flat expansion similar to the sexual generation of many liverworts. Fig. 3 shows

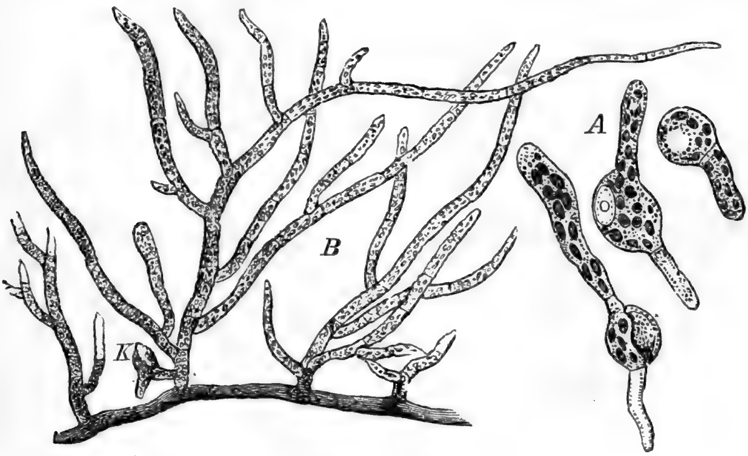

FIG. 3.

the germinating spores of *Funaria hygrometrica*, at A, and the fine branching, green threads (B) that are afterward produced. The true moss-plant, with its small stems, and fine, regularly arranged leaves, originates from specialized cells in the protonema, or alga form. K, in Fig. 3, shows the rudiment of a leaf-bearing axis. On the conspicuous moss-plant, arising from such small beginnings, the sexual organs are borne. They are usually produced in clusters at the ends of the leafy axes. Most mosses have only one sex represented in a single tip, and some species have the separation of the sexes so complete that a plant bears only one kind. Mosses, as well as trees and shrubs, are sometimes monœcious or diœcious. Fig. 4 shows the male and female organs very much magnified. The antheridium, A, is a stalked, club-shaped structure, inclosing a large number of sperm-cells, *b*, each of which produces a spiral spermatozoid, *c*. These minute bodies move rapidly by means of two cilia, and find their way to the neck of the female organ, B. The germ-cell, *b*, to be fertilized, is at the base of the long structure, with a mucilaginous channel, *h*, leading down to it. After the spermatozoids have united with the germ-cell, the latter soon begins a new growth, and a young sporangium results. Fig. 5 shows different stages in the development of the sperm-case; and in

Fig. 6 is seen a vertical section of one fully grown, showing the various parts of theca, calyptera, operculum, etc. In this complicated sporangium, small spores in great numbers are produced, and with their perfection ends the last chapter in the life-history of the moss.

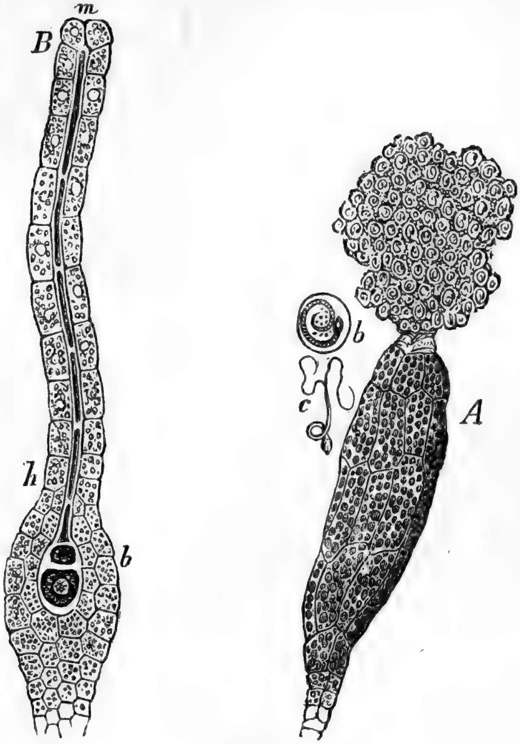

Fig. 4.

The spore produces a fine filamentous growth, from which the true moss-plant develops. This is the sexual generation, and from fertilized germ-cells, which it bears, the asexual generation is produced, consisting of the spore-case, its stalk, and, most important of all, the many spores.

We now come to a more exalted group of plants, and the first of the cryptogams with spiral vessels and other ducts in the wood. The ferns are so familiar to all that any description of their general appearance is unnecessary. The first generation proceeds directly from the spore, and consists of a simple green expansion which is short-lived and very small, not usually exceeding half the size of a small finger-nail. This prothallus, as it is termed, has small, root-like hairs which fix it to the earth or elsewhere. The prothallia are to be seen in large numbers on the sides of flower-pots in neglected greenhouses. Each little green scale is a young fern-plant during its sexual generation. The male and female organs are much the same shape as those of mosses.

Fig. 7 shows a prothallus seen from the under side and much magnified; *h*, are the root-hairs; *an*, antheridia; and *ar*, archegonia. The antheridia produce cork-screw coiled antherozoids which pass to the archegonia and fertilize their germ-cells. The second generation de-

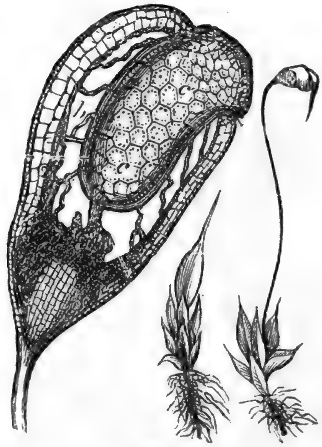

Fig. 6.

Fig. 5.

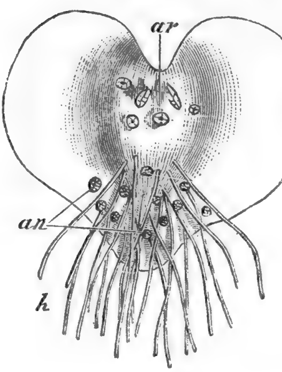

Fig. 7.

velops from the germ-cell, as shown in Fig. 8. By a further growth of stem and fronds, the well-known state of the fern is produced. The spores are borne on the under side or edges of the fronds. In some species the spores are formed only on a portion of the fronds, the others being sterile. The plant commonly known as the fern does not have any male or female parts, and may live for many years, producing countless spores. The sexes are confined to the minute scale, which is so small as to pass unnoticed, and if seen would not suggest its origin or destiny. Dr. Farlow has discovered instances where the prothallia produced fern-plants without the usual process of fertilization. These are only the exceptions which prove the rule.

There is a little group of ferns to which the "adder-tongue" belongs, that has the prothallus underground, consisting of an irregular mass of colorless cells, which may not exceed one twenty-fifth of an inch in diameter. This group forms another step toward a greater simplicity of the sexual generation in plants. The spores of the *Ophioglossaceæ* are developed less superficially on the fronds than in the lower orders of ferns. This is a morphological point which is worthy of mention here. The whole structure of the asexual generation is more highly developed than in other ferns, while the sexual generation is much reduced and simplified.

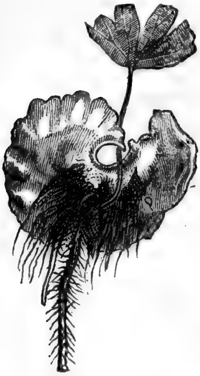

Fig. 8.

The *Equisetaceæ*, or horse-tails, form a small group of flowerless plants, with hollow, jointed stems and cone-like spore-heads (Fig. 9). The scouring-rush, with its rough, grooved stem, is a leading member of this family. The prothallia are small and irregularly branched, and in most species the male and female parts are on separate plants (diœcious). The antheridia-bearing prothallia are much smaller than the female, the latter being sometimes half an inch in length. The structure of the male and female organs is

Fig. 9.

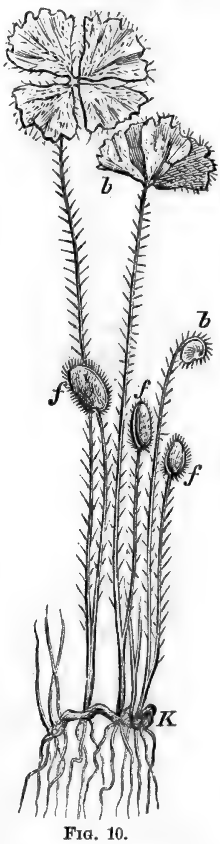

Fig. 10.

much the same as in ferns. The antherozoids are larger, and the archegonia are more deeply situated in the prothallus. The conspicuous horse-tail develops from the fertilized germ-cell, and constitutes the spore-bearing asexual generation. In some species a colorless or brownish stem comes up in early spring, which bears the spores on whorls of modified leaves, and afterward perishes. Later in the spring the green stems arise. This shows a greater differentiation in the asexual generation.

Next above the horse-tails come the *Rhizocarpeæ*, a small cryptogamic group of water-plants, inhabiting ditches, streams, etc. Thus far, in our upward course, we have found only one kind of spore. Here there are two sorts, the large and the small. The former produce archegonia, and are therefore essentially female, while the smaller spores are male, and produce antherozoids. These spores are formed in spore-cases, termed sporocarps. Fig. 10 shows a plant of *Marsilia salvatrix*, reduced one half; K is the terminal bud; *b b*, leaves; *ff*, sporocarps. In these last the spores of both sizes are produced. The contents of the small or male spores divide and develop into a number of antherozoids, which afterward escape through a rupture in the spore-wall. A small portion of the spore does not take part in this formation of antherozoids, and may be considered the prothallus. In the large or female spore the prothallus is larger, and only one end of the spore bears a single archegonium. In Fig. 11, at A, is shown

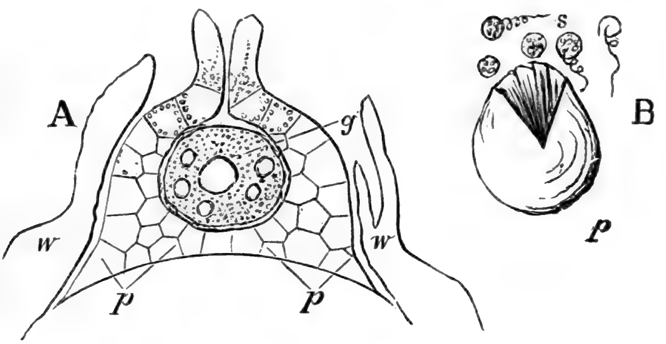

FIG. 11.

a vertical section of the archegonium end of a large spore; *w w* are parts of the ruptured spore-wall; *p p* is the prothallus, and *g* the germ-cell. At B is a male spore of the same species, with its wall ruptured, and the corkscrew-like antherozoids, *s*, escaping. The second generation soon develops from the fertilized germ-cells, and produces the mature plant. It is seen that the sexual generation in the Marsilia group is reduced to two kinds of spores, with their rudimentary prothallia. In another branch of the *Rhizocarpeæ*, while in most features the life-history is as just described, there is a further differentiation in the sporocarps. The male and female spores are produced in separate sporocarps. Fig. 12 shows a section through three spore-cases, two of them bearing the small males pores, and the third, *a*, the large female spores.

In the next higher group, as arranged by botanists, we find the club-mosses ; these are common plants with trailing or upright very leafy stems. Fig. 13, A, shows the tip of a spore-bearing branch, natural size, and B a longitudinal section much enlarged. The large spores are borne in sporangia on one side, while the small ones are on the left. The differentiation has now reached the place where there is a definite arrangement of the sporangia on the plant bearing them. In the development of the male spores the cells in which the antherozoids form are not produced directly from the spore-contents. This is a valuable link in the chain of relationship which binds this group with higher plants—in fact, helps to bridge what gulf there may have been thought existing between the flowerless and flowering plants. The ripe male spore-contents are changed into a few cells, one of which remains sterile and is considered the prothallus, while from the other cells—which taken as a whole constitute the antheridium—the cells which afterward bear the antherozoids are formed. In the genus *Selaginella* the female spore produces a small prothallus, as shown at 1, Fig. 14. The portion above *d d*, in this cross-section of the spore, is the prothallium, and at *e e* are two embryo plants. At 2 is a young archegonium not opened ; 3 shows one further advanced, with the fertilized germ-cell divided. A is a male spore, showing the cell-division ; D is a later state of the same, with the large antheridium filled with sperm-cells. The rudimentary prothallus is at *v*. The female is still more simple in *Isoetes*, shown in Fig. 15 : 1 is the longitudinal section of the female spore, with an archegonium, *a r*, at the top ; 2 shows the early differentiation of cells into archegonia, *a r*, *a r*, with their germ-cells, *g g* ; 3, 4, and 5 show successive stages in the development of the germ-cell.

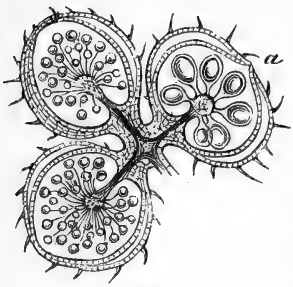

FIG. 12.

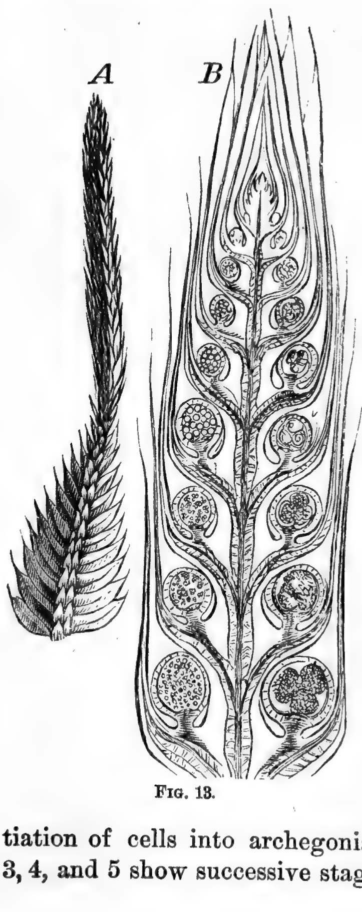

FIG. 13.

There is a close resemblance to the embryo sac of *Gymnosperms* (pines, spruces, etc.). The prothallus is very much reduced, and pro-

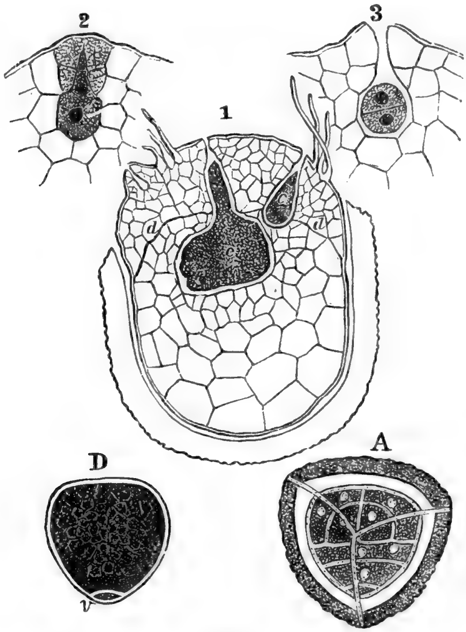

FIG. 14.

jects through the slit in the spore-covering. In the development of the female germ-cell after fertilization, there is an elongation of the upper part (see *e*, Fig. 14), forming the part called the suspensor, a

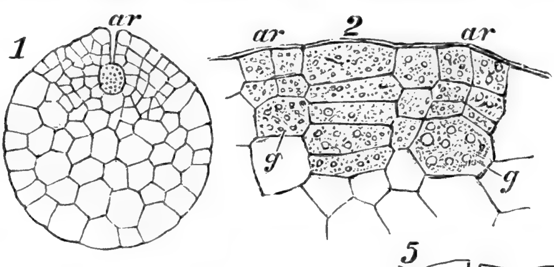

FIG. 15.

body which is not found in other cryptogams, but is present in embryos of flowering plants.

We now pass to phenogamous or flowering plants, in which the small male spore of the higher cryptogams takes the name of pollen-grains, and the larger female spore is known as the embryo sac. The latter does not sever its connection with the mother-plant until after an embryo plant has formed. On this account the prothallium—which we have seen as an independent structure in ferns and diminishing gradually as we ascended in the scale of flowerless plants—is here but feebly developed. The flower-bearing plant, whether herb, shrub, or tree, is the asexual generation producing two kinds of structures, which, by their development and union of parts, produce a plant like the one from which the sexual generation sprang. The pollen-grain is usually a small spherical or oval body that, when mature, separates from the case (anther) in which it was formed. Figs. 16 shows the form of some simple pollen-grains. Grain A shows the rudimentary prothallium as a small cell, *y;* B is a pollen-grain forming the tube. Much the same is seen at C and D, excepting that the prothallium is made up of three small cells. In structure and function these pollen-grains are almost identical with the male spores of higher cryptogams. The embryo sac is more or less surrounded by the substance of the parent-plant, and develops within itself a prothallus of small size which is known as the endosperm, and is a store-house of nourishing matter for the young embryo. One or more cells form the homologue of the archegonia in higher cryptogams with its female germ. The male cell or pollen-grain no longer develops a number of mobile, fertilizing antherozoids or spermatozoids; but, instead, the whole pollen-grain passes to a receptive surface (stigma) situated somewhere near the female organ, from which it sends out a tube that penetrates the tissue provided for its passage (style) until it reaches its destination and mingles its contents with those of the female cell. Circumstances obtain in the flowering plants which render mobile bodies like spermatozoids worthless as a means of fertilization. In many cases the male element needs to pass from one tree to another, and even from one country to another. The first observed result of fertilization is the formation of the suspensors, mentioned under *Selaginella.* At the lower end of the suspensor the young plantlet is formed with its one or more small seed-leaves and a short root and stem. In this growth the food-material in the endosperm is frequently entirely exhausted. The ovule, as the female cell with its immediate surrounding tissue is

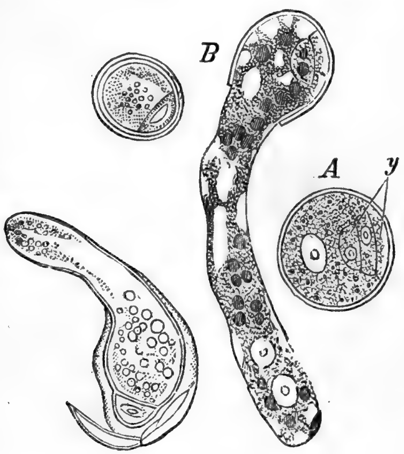

Fig. 16.

termed, becomes inclosed with one or more coats of varying thickness, and, when the whole structure has reached maturity and is ready to separate from the parent-plant, we have the familiar body known as a seed. The seed is an independent plant-structure designed to develop into a mature herb, shrub, or tree, when the conditions are favorable for its germination and growth.

The lowest class of flowering plants is the *Gymnosperms*—which includes the cycads and cone-bearing plants. The ovules are naked, and the embryo develops considerable endosperm. This corresponds to the prothallus of higher cryptogams, as in it the corpuscula, which correspond with archegonia, are formed. The pollen-grains are several-celled, thus suggesting a prothallus, especially as only a part of the grain takes part in the formation of the tube and the male fertilizing fluid. The gymnosperms evidently occupy an intermediate place between the higher cryptogams and the angiosperms or flowering plants with their ovules inclosed in an ovary. This last class contains the great mass of plants with evident floral organs, and is divided into the exogens, like the oak, apple, and rose, and the endogens, illustrated by the grasses and cereal grains.

The points that interest us most in the present consideration are, that, unlike the gymnosperms, the ovules are inclosed in an ovary; the endosperm forms in the embryo sac after fertilization, and the pollen-grain sends out its tube without previous cell-division. The pollen-grains often have no rudimentary prothallus. The first result of fertilization is the formation of a cellulose wall around the germ-cell. This cell soon divides, forming the suspensor at the lower end, from which the embryo plantlet is developed. The endosperm-cells form at the same time at the opposite end of the embryo sac. Fig. 17, A, shows a longitudinal section of a young ovule shortly after fertilization. The embryo sac is at *e*, with a small embryo at the left end, and free endosperm-cells formed at the other. The embryo is shown more magnified at B, and at C is seen the same more advanced. The endosperm is rich in food-materials for the growing embryo, and may be entirely absorbed and the space occupied by the latter.

FIG. 17.

It now remains for us to determine the extent of the sexual generation in the flowering plants. Among gymnosperms it is not difficult to see that it consists of the pollen-grain and the embryo sac with its endosperm. The male prothallus is reduced and rudimentary, and one cell of the pollen-grain, representing the antheridium, produces a tube instead of antherozoids. The endosperm is the female prothallus, and in it the germ-cell develops. The asexual generation is the plant that grows from the fertilized germ. In the angiosperms the sexual generation is reduced to its simplest form, namely, a single cell for the male part, and one or a few cells for the female.

We thus see that the alternation of generation, viewed in the light of its presentation among mosses and ferns, practically disappears in the higher flowering plants. The sexual generation is so reduced and merged with the asexual that the two seem to become one, and, were it not that the gradual simplifying of this generation may be traced, it would not be thought to exist.

If we recapitulate, in the reverse order, it is easy to evolve a conspicuous, independent plant from the single-celled pollen-grain, and a similar self-supporting plant from the simple embryo sac. The first step back is to the gymnosperms, where the ovules are not in ovaries, and the embryo sac has a rudimentary prothallus in the endosperm. The pollen-grain is made up of more then one cell. From this group we pass to the *Selaginellæ*, in which we have the female spore, with its rudimentary prothallus, and the smaller male spore, having one cell for the prothallus, the remaining ones forming the antherozoids. Descending to the *Rhizocarpeæ*, both the spores increase in size and complexity. Further back we come to the higher orders of ferns, with but one kind of spore, the small prothallus, bearing both sexual organs. The lower orders have this sex-bearing generation much more developed. In the mosses and *Hepaticæ* the sexual generation surpasses the asexual in size and complexity.

The relative size of the two generations might be represented to the eye by drawing a rectangle with a diagonal, Fig. 18. One triangle

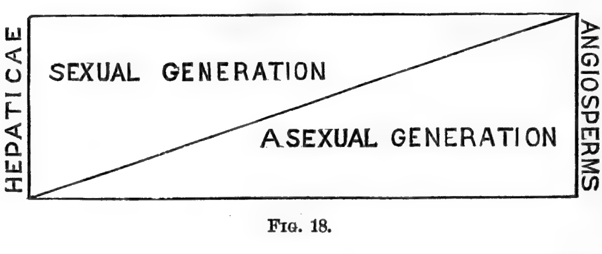

Fig. 18.

would indicate the size and complexity of the sexual generation, while the other represented the asexual generation. The sexual generation diminishes from the *Hepaticæ* to the angio-sperms, while the asexual generation increases.

The engravings here employed are from treatises on botany by Sach, Prantl, and Bessey, to whom the writer is also indebted for many of the facts brought together.

EVOLUTION AND DISSOLUTION OF THE NERVOUS SYSTEM.*

By J. HUGHLINGS JACKSON, M. D., F. R. S.

MR. PRESIDENT AND GENTLEMEN: The doctrine of evolution daily gains new adherents. It is not simply synonymous with Darwinism. Herbert Spencer applies it to all orders of phenomena. His application of it to the nervous system is most important for medical men. I have long thought that we shall be very much helped in our investigations of diseases of the nervous system by considering them as reversals of evolution—that is, as dissolutions. Dissolution is a term I take from Spencer as meaning the reverse of the process of evolution. The subject has been worked at for many years. About half a century ago, Laycock applied the doctrine of reflex action to the brain. Sir Charles Bell, in speaking of degrees of drunkenness, and Baillarger, in remarking upon aphasia, have pointed out that there is a reduction from the voluntary toward the automatic. The late Dr. Anstie's researches † are perhaps the most valuable of all contributions toward the study of diseases of the nervous system as examples of dissolution, although he did not use that term. I refer also with great respect to the most valuable and highly original work which Ross, Ribot, and Mercier have done in the same direction. The brilliant researches of Hitzig and Ferrier, besides their obvious great value in other ways, are of very great value in supporting the doctrines of evolution and dissolution of the nervous system. In this connection I gladly mention with great respect a recent valuable paper on cerebral localization by Dr. Sharkey.

Wishing as soon as possible to give illustrations of dissolution, I will make the necessary preliminary as short as I can. I speak only of the most striking aspects of evolution and dissolution, leaving entirely out of account some very important factors specially insisted upon by Herbert Spencer. I regret that time renders it necessary for me to simplify my subject by serious omissions. Spencer, to whom I am under the deepest obligation, must not be judged by my present application of his doctrines, or rather of part of them. I have to ask pardon for the use in this lecture of some popular terms. "Most voluntary," though it has a technical sound, is, when used in contrast to "most automatic," a popular term, and later on it will be discarded. I have also to acknowledge an omission; I speak for the most part of the cerebral system only, almost ignoring all divisions of the cerebel-

* This is the first of the Croonian Lectures, delivered before the Royal College of Physicians by J. Hughlings Jackson, M. D., F. R. S., Fellow of the Royal College of Physicians, Physician to the Hospital for the Paralyzed and Epileptic, and to the London Hospital.

† "Stimulants and Narcotics."

lar system. For the present I neglect the absolute distinction there really is between mental and nervous states.

Beginning with evolution, and dealing only with the most conspicuous parts of the process, I say of it that it is an ascending development in a particular order. I make three statements, which, although from different stand-points, are about the very same thing: 1. Evolution is a passage from the most to the least organized—that is to say, from the lowest well-organized centers up to the highest least organized centers. Putting this otherwise, the process is from centers comparatively well organized at birth up to those, the highest centers, which are continually organizing through life. 2. Evolution is a passage from the most simple to the most complex; again from the lowest to the highest centers. There is no inconsistency whatever in speaking of centers being at the same time most complex and least organized. Suppose a center to consist of but two sensory and two motor elements, if the sensory and motor elements be well joined, so that "currents flow" easily from the sensory into the motor elements, then that center, although a very simple one, is highly organized. On the other hand, we can conceive a center consisting of four sensory and four motor elements, in which, however, the junctions between the sensory and the motor elements are so imperfect that the nerve-currents meet with much resistance. Here is a center twice as complex as the one previously spoken of, but of which we may say that it is only half so well organized. 3. Evolution is a passage from the most automatic to the most voluntary. The triple conclusion come to is, that the highest centers, which are the climax of nervous evolution, and which make up the "organ of mind," or physical basis of consciousness, are the least organized, the most complex, and the most voluntary. So much for the positive process by which the nervous system is "put together"—evolution. Now for the negative process, "the taking it to pieces"—dissolution.

Dissolution being the reverse of the process of evolution just spoken of, little need be said about it here. It is a process of undevelopment; it is a "taking to pieces" in the order from the least organized, the most complex, and the most voluntary, toward the most organized, most simple, and most automatic. I have used the word "toward," for if dissolution were up to and inclusive of the most organized, etc., if, in other words, dissolution were total, the result would be death. I say nothing of total dissolution in these lectures. Dissolution being partial, the condition in every case of it is duplex. The symptomatology of nervous diseases is a double condition; there is a negative and there is a positive element in every case. Evolution not being entirely reversed, some level of evolution is left. Hence the statement "to undergo dissolution" is rigidly the equivalent of the statement "to be reduced to a lower level of evolution." In more detail, loss of the least organized, most complex, and most voluntary implies the retention of the more organized, the less complex, and the more automatic. This is not a mere truism; or, if it be, it is one that is often neglected. Disease is said to cause the symptoms of insanity. I submit that disease only produces negative mental symptoms answering to the dissolution, and that all elaborate positive mental symptoms (illusions, hallucinations, delusions, and extravagant conduct) are the outcome of activity of nervous elements untouched by any pathological process—that they arise during activity on the lower level of evolution remaining. The principle may be illustrated in another way without undue recapitulation. Starting this time with health, the assertion is that each person's normal thought and conduct are, or signify, survivals of the fittest states of what we may call the topmost layer of his highest centers, the normal highest level of evolution. Now, suppose that from disease the normal highest level of evolution (the topmost layer) is rendered functionless. This is the dissolution, to which answer the negative symptoms of the patient's insanity. I contend that his positive mental symptoms are still the survival of his fittest states—are survivals on the lower, but then highest, level of evolution. The most absurd mentation and most extravagant actions in insane people are the survival of their fittest states. I say "fittest" not "best"; in this connection the evolutionist has nothing to do with good or bad. We need not wonder that an insane man believes in what we call his illusions; they are his perceptions. His illusions, etc., are not caused by disease, but are the outcome of activity of what is left of him (of what disease has spared), of all there then is of him; his illusions, etc., are his mind.

After this brief sketch I mention what may appear to be a drawback. Scarcely ever, if ever, do we meet with a case of dissolution which we can suppose to be the exact opposite of evolution. Often enough, however, do we meet with its near opposites. I will try to dissipate any difficulties that may arise. We make two broad divisions of cases of dissolution—uniform and local.

In uniform dissolution the whole nervous system is under the same conditions or evil influence, the evolution of the whole nervous system is comparatively evenly reversed. In these cases the whole nervous system is "reduced," but the different centers are not equally affected. An injurious agency, say alcohol, taken into the system, flows to all parts of it, but the highest centers, being least organized, "give out" first and most; the middle centers, being more organized, resist longer, and the lowest centers, being most organized, resist longest. Did not the lowest centers for respiration and circulation resist more than the highest do, death by alcohol would be a very common thing. Another way of stating the foregoing is to say that increasing uniform dissolution follows a "compound order." Three stages may be rudely symbolized thus, using the initial letters of highest, middle, and lowest centers. First stage or depth of dissolution, h; second stage, h_2+m;

third stage, h_3+m_2+l; etc. Although I shall say very little later on of involvement of middle and lowest centers in cases of uniform dissolution, it is most important, especially with regard to clear notions on localization, to recognize that the order of dissolution is a compound order.

The next division is local dissolution. Obviously disease of a part of the nervous system could not be a reversal of the evolution of the whole; all that we can expect is a local reversal of evolution, that there should be loss in the order from voluntary toward automatic in what the part diseased represents. Repeating in effect what was said on uniform dissolution, it is only when dissolution occurs in all divisions of the highest centers that we can expect a reduction from the most voluntary of all toward the most automatic of all. Dissolution may be local in several senses. Disease may occur on any evolutionary level on one side, or on both sides; it may affect the sensory elements chiefly, or the motor elements chiefly. It must be particularly mentioned that there are local dissolutions of the highest centers. It will be granted that in every case of insanity the highest centers are morbidly affected. Since there are different kinds as well as degrees of insanity, for examples, general paralysis and melancholia, it follows, of necessity, that different divisions of the highest centers are morbidly affected in the two cases. Different kinds of insanity are different local dissolutions of the highest centers.

I now come to give examples of dissolution. I confess that I have selected cases which illustrate most definitely, not pretending to be able to show that all the diseases of which we have a large clinical knowledge exemplify the law of dissolution. However, I instance very common cases, or cases in which the pathology has been well worked out; they are cases dependent on disease at various levels from the bottom to the top of the central nervous system. Most of them are examples of local dissolution:

1. Starting at the bottom of the central nervous system, the first example is the commonest variety of progressive muscular atrophy. We see here that atrophy begins in the most voluntary limb, the arm; it affects first the most voluntary part of that limb, the hand, and first of all the most voluntary part of the hand; it then spreads to the trunk, in general to the more automatic parts. To speak of a lower level of evolution in this case is almost to state a barren truism. At a stage when the muscles of the hand only are wasted, there is atrophy of the first or second dorsal anterior horn; the lower level of evolution is made up of the higher anterior horns for muscles of the arm. This statement, however, is worth making, for it shows clearly that by higher and lower is meant anatomico-physiologically higher or lower.

2. Going a stage higher we come to hemiplegia, owing to destruction of part of a plexus in the mid-region of the brain. Choosing the

commonest variety of hemiplegia, we say that there is loss of more or fewer of the most voluntary movements of one side of the body; we find that the arm, the more voluntary limb, suffers the more and longer; we find, too, that the most voluntary part of the face suffers more than the rest of the face. Here we must speak particularly of the lower level of evolution remaining; strictly we should say collateral and lower. We note that, although unilateral movements (the more voluntary) are lost, the more automatic (the bilateral) are retained. Long ago this was explained by Broadbent. Subsequent clinical researches are in accord with his hypothesis. The point of it is that the bilateral movements escape in cases of hemiplegia in spite of destruction of some of the nervous arrangements representing them; the movements are doubly represented—that is, in each half of the brain. Hemiplegia is a clear case of dissolution, loss of the most voluntary movements of one side of the body with persistence of the more automatic movements.

3. The next illustration is paralysis agitans. Apart from all speculation as to the seat of this disease, the motorial disorder illustrates dissolution well. In most cases the tremor affects the arm first, begins in the hand, and in the thumb and index-finger. The motorial disorder in this disease becomes bilateral; in an advanced stage paralysis agitans is double hemiplegia with rigidity—is a two-sided dissolution.

4. Next we speak of epileptiform seizures which are unquestionably owing to disease in the mid-region of the brain (middle motor centers). Taking the commonest variety, we see that the spasm mostly begins in the arm, nearly always in the hand, and most frequently in the thumb or index-finger, or both; these two digits are the most voluntary parts of the whole body.

5. [The next illustration was by cases of temporary paralyses after epileptiform seizures.]

6. Chorea is a disease in which the limbs (the most voluntary parts) are affected more than the trunk (the more automatic parts), and the arms (the more voluntary limbs) suffer more than the legs. The localization of this disease has not been made out; symptomatically, however, it illustrates dissolution. Chorea has a special interest for me. The great elaborateness of the movements points to disease "high up"—to disease on a high level of evolution. Twenty years ago, from thinking on its peculiarities, it occurred to me that some convolutions represent movements—a view I have taken ever since.

7. Aphasia. This well illustrates the doctrine of dissolution, and in several ways. We will consider a case of complete speechlessness: (*a.*) There is loss of intellectual (the more voluntary) language, with persistence of emotional (the more automatic) language. In detail the patient can not speak, and his pantomime is of a very simple kind; yet, on the other hand, he smiles, frowns, varies the tones of his voice (he may be able to sing), and gesticulates as well as ever. Gesticula-

tion, which is an emotional manifestation, must be distinguished from pantomime, which is part of intellectual language. (*b.*) The frequent persistence of "Yes" and "No," in the case of patients who are otherwise entirely speechless, is a fact of extreme significance. We see that the patient has lost all speech, with the exception of the two most automatic of all verbal utterances. "Yes" and "No" are evidently most general, for they assent to or dissent from any statement. In consequence of being frequently used, the correlative nervous arrangements are of necessity highly organized, and, as a further consequence, they are deeply automatic. (*c.*) A more important, though not more significant, illustration is that the patient who can not get out a word in speech nevertheless understands all that we say to him. Plainly this shows loss of a most voluntary service of words, with persistence of a more automatic service of words. We find illustrations in small corners. (*d.*) There are three degrees of the utterance "No" by aphasics. A patient may use it emotionally only—a most automatic service; another patient may also be able to reply correctly with it—a less automatic but still very automatic service. (Here there is some real speech.) There is a still higher use of it, which some aphasics have not got. A patient who can reply "No" to a question may be unable to say "No" when told to do so. You ask the aphasic, "Is your name Jones?" he replies, "No." You tell him to say "No," he tries and fails. You ask, "Are you a hundred years old?" He replies, "No." You tell him to say "No." He can not. While not asserting that the inability to say "No" when told is a failure in language, it is asserted that such inability with retention of power to use the word in reply illustrates dissolution. (*e.*) A patient who is speechless may be unable to put out his tongue when told to do so; that he knows what is wanted is sometimes shown by his putting his finger in his mouth to help out the organ. That the tongue is not paralyzed in the ordinary sense is easily proved. The patient swallows well, which he could not do if his tongue were as much paralyzed as "it pretends to be." Besides, on other occasions he puts out his tongue, for example, to catch a stray crumb. Here is a reduction to a more automatic condition; there is no movement of the tongue more voluntary than that of putting it out when told.

[The lecturer then remarked on swearing and on the utterance of other and innocent ejaculations by aphasics, remarking that some of these utterances had elaborate propositional structure but no propositional value. The patients could not repeat, say, what under excitement they uttered glibly and well. He spoke next of the frequent retention of some recurring utterance by aphasics, such as "Come on to me." These were not, from the mouth of the aphasic, of any propositional value, were not speech. He had no explanation to offer of these, but stated the hypothesis that they were the words the patient was uttering, or was about to utter, at the time he was taken ill.]

8. So far I have spoken of local dissolution occurring on but one-half of the nervous system on different levels. Coming to the highest centers I speak of uniform dissolutions—of cases in which all divisions of these centers are subjected to the same evil influence. I choose some cases of insanity. In doing this I am taking up the most difficult of all nervous diseases. I grant that it is not possible to show in detail that they exemplify the principle of dissolution, but choosing the simplest of these most complex cases we may show clearly that they illustrate it in general. I take a very commonplace example—delirium in acute non-cerebral disease. This, scientifically regarded, is a case of insanity. In this, as in all other cases of insanity, it is imperative to take equally into account not only the dissolution but the lower level of evolution that remains. The patient's condition is partly negative and partly positive. Negatively, he ceases to know that he is in hospital, and ceases to recognize persons about him. In other words, he is lost to his surroundings, or, in equivalent terms, he is defectively conscious. We must not say that he does not know where he is because he is defectively conscious; his not knowing where he is, is itself defect of consciousness. The negative mental state signifies, on the physical side, exhaustion, or loss of function, somehow caused, of some highest nervous arrangements of his highest centers. We may conveniently say that it shows loss of function of the topmost layer of his highest centers. No one, of course, believes that the highest centers, or any other centers, are in layers; but the supposition will simplify exposition. The other half of his condition is positive. Besides his not knowings, there are his wrong knowings. He imagines himself to be at home or at work, and acts as far as practicable as if he were; ceasing to recognize his nurse as a nurse, he takes her to be his wife. This, the positive part of his condition, shows activity of the second layer of his highest centers; but which, now that the normal topmost layer is out of function, is the then highest layer; his delirium is the "survival of the fittest states," on his then highest evolutionary level. Plainly, he is reduced to a more automatic condition. Being (negatively) lost, from loss of function of the highest, latest developed, and least organized, to his present "real" surroundings, he (positively) talks and acts as if adjusted to some former "ideal" surroundings, necessarily the more organized.

I now make some general remarks on the eight illustrations, in order to prevent certain misunderstanding. It is asserted, again, that each of the eight cases is a different dissolution. All that is meant is that each shows a reduction from the voluntary toward the automatic in what the center, or part of it, which is diseased, represents. If we take extreme cases, the case of progressive muscular atrophy and the case of insanity (delirium in acute non-cerebral disease), we say that the two are alike, because in each there is reduction to a more automatic condition, and we say, too, that they are very unlike, the parts of the nervous system morbidly affected being exceedingly different.

I have so far almost ignored the distinction between nervous states and mental states. Now, if the case of insanity be considered as a series of mental phenomena only, it would be absurd to compare or even to contrast it with progressive muscular atrophy, which is a series of physical phenomena only. But no difficulty can arise if it be understood that insanity, or "disease of the mind," is with medical men disease of the highest nervous centers revealing itself in a series of mental phenomena. We compare and contrast disease of the highest centers with disease of some anterior horns (some lowest centers) revealing itself in atrophy of certain muscles. But, acknowledging this, it may be said that the two things are so exceedingly different that it is frivolous to compare or even to contrast them on any basis. Yet, no one denies that each is a morbid affection of the central nervous system; this being granted, the rejoinder to those who insist on the extreme unlikeness is that the lesion in one is at the very bottom, in the other at the very top, of the central nervous system; two lesions can not possibly be farther apart in the central nervous system. Still it may be said that classification, on the principle of dissolution, if true, is of no value; that it is of no use making an orderly ascending series from progressive muscular atrophy to insanity—of no use showing that progressive muscular atrophy is reduction to a more automatic condition in a small corner on the lowest level, that hemiplegia is such reduction on a larger scale higher up, and that insanity is such a reduction on the topmost level, and on the largest scale—that even if this kind of work could be thoroughly well done it is not worth any one's while to do it. I grant that such a classification is not of direct value, but yet I think it of much indirect value for clinical purposes. We require in our profession two kinds of classification. The use of two classifications may be easily illustrated. There is a classification, or strictly an arrangement, of plants by the farmer for practical purposes, and there is a classification of plants by the botanist for the advancement of biology. I submit that there is no more incongruity in classing together progressive muscular atrophy and insanity upon the basis mentioned than there is in classifying the bamboo with common grass, or the hart's-tongue with the tree-fern in a botanist's garden. Such kind of classification of plants would be absurd in a farm or kitchen-garden, and so would a classification of diseases of the nervous system upon the principle of dissolution be absurd in an asylum or in the wards of a hospital. I know of no other basis on which cases of insanity, diseases of the highest centers, can be studied comparatively with non-mental diseases of the nervous system—diseases of lower centers.

I next speak of different depths of dissolution. The deeper the dissolution the shallower the level of evolution remaining. In hemiplegia, owing to lesion of the internal capsule, there are, according to the gravity of the lesion, three degrees or depths (of course the division into three degrees is arbitrary). In the first degree there is some paralysis of the face, arm, and leg ; in the second degree there is more paralysis of these parts, and, in addition, there is a greater range of paralysis ; the patient's head and eyes are turned from the side paralyzed. Here is illustrated what I call "compound order." The difference between the two degrees is not that in the second there is more paralysis only, nor that there is a greater range of paralysis only, but in both respects ; there is more paralysis of the parts affected in the first degree and extension of range of paralysis to parts beyond them. An adequate doctrine of localization has to account for such increase of paralysis in compound order on increasing gravity of lesions. In the third degree of, or rather beyond, hemiplegia there is universal immobility. In this degree the patient has lost consciousness, and this loss may be said to explain why he does not move the other or "second" side of his body. I hope to show later that explanations of materialistic states by psychical states are invalid. I wish here to bring evidence in support of the opinion I have long held, that all parts of both sides of the body are represented in each half of the brain. The view I take is simply an extension of Broadbent's hypothesis, already referred to. My supposition is that the limbs of the two sides are very unequally represented in each half of the brain, while the bilaterally acting muscles are very nearly equally represented in each half. Evidence that at least some parts of both sides of the body are represented in each half of the brain is that consecutive to a negative lesion of one internal capsule there is wasting of nerve-fibers "descending" into both sides of the spinal cord.

Degrees of epileptiform seizures illustrate different depths of dissolution. There are degrees of these from (to take an example) spasm of the thumb and index-finger to universal convulsion.* That these degrees are compound is very evident. The first stage of the fit is, to speak roughly, that the arm is a little affected ; the second stage is that the arm is more affected, and the face a little ; the third stage is that the arm is most affected, the face much, and the leg a little. This compound order of spreading, which any adequate doctrine of localization has to account for, may be symbolized thus : a, then a_2+f, then a_3+f_2+l, etc. There are degrees beyond this to universal spasm ; these cases I submit supply further evidence that both sides of the body are represented in each half of the brain. Certain experiments of Franck and Pitres † bear in a most important way on the question

* I am not speaking of epileptic attacks, which depend, I think, on discharges beginning in parts of centers of a higher, the highest, level of evolution. A man long subject to very limited epileptiform seizures may at length have seizures beginning in the same way, and becoming universal, but these are not epileptic seizures, they are only more severe epileptiform seizures.

† "Archives de Physiologie," 15 Août, 1883, No. 6.

as to double representation. After exposing the so-called motor region * of each half of the brain of a dog, they removed the motor region on one half, and then found that faradization of the "arm-center" on the half intact (left) produced universal convulsion; they found, too, that the spasm followed a particular order—that it affected the right arm (so to call it), then the right leg, then the left leg, and then the left arm.† Here seems to be evidence that both sides of the body are represented in each half of the brain, and also that the two sides are differently represented in each half. The distinguished French physicians to whose observations I have referred hold, I must mention, that "*le cerveau commence l'attaque, la protubérance, le bulbe et la moëlle la généralisent.*" If this be so, still proof is given that movements of all parts of the body are under command of, if not represented fully in, each half of the brain. This is a matter of extreme importance for the doctrines of evolution and dissolution. The evidence, as I read it, is that the middle motor centers (a discharge beginning in parts of which causes epileptiform seizures) of each half of the brain represent movements of both sides of the body. Other facts will, I think, show that the highest motor centers rerepresent in more intricate combinations all that the middle centers have represented in simpler combinations; a discharge beginning in part of these more evolved centers produces an epileptic seizure, which is, so to speak, a "more evolved convulsion" than an epileptiform seizure.

[In the remainder of the lecture many degrees of aphasia were instanced, to illustrate again different depths of dissolution and different shallows of evolution remaining, and also to illustrate the dual symptomatology of disease. The wrong words uttered by a patient who has "defect of speech" are owing to activities of healthy nervous arrangements, while the disease is answerable only for the patient's not saying the right words. The states comparable in a case of "defect of speech" with the states in the case of another aphasic who can only say "No" are: (1) negatively, the inabilities in the former to say the right words with the latter's speechlessness, and (2) positively, the utterance of numerous wrong words by the former with the retention of "Yes" and "No" only by the latter. In the former the dissolution is slight, and the level of evolution very high; in the latter the dissolution is deep, and the level of evolution very shallow.]—*The Lancet.*

* I say "so-called motor region" not because I deny that the parts in this region are motor—I call them the middle motor centers—but because I believe the parts in front to be motor also, to be the highest motor centers.

† "L'epilepsie peut donc se généraliser malgré la destruction préalable de la zone motrice d'un côté, malgré la section longitudinale complete du corps calleux." (Franck and Pitres.)

THE POLE AND WIRE EVIL.

By OLIVER E. LYMAN.

WHEN any system of business is so conducted as to arouse a feeling of opposition on the part of right-minded citizens generally, it is safe to say that some evil exists, which renders the immediate reformation of that system, in whole or in part, a matter of public importance. Judged by this standard, our telegraphic and electrical system would seem to be in need of reformation. That it has evil features no one can deny, and nothing about it, perhaps, is more obnoxious than the method at present in vogue in cities of constructing lines overground—a method which has increased in obnoxiousness with the recent remarkable growth and expansion of the electrical system.

The mode of construction has not been conformed to the changed conditions which this growth, simultaneously with the progress of civilization, has brought about. The same method of hanging wires on posts which was introduced by Professor Morse has been persevered in ever since, regardless of the fact that the conditions which rendered his single line across an open country, twoscore years ago or so, innocent and proper, are not the same in our densely-built and populated cities of to-day. Ignoring other causes of change, the telegraphic business, most of which is conducted in cities, has wonderfully increased. In place of his one company there were in 1880 seventy-seven telegraphic and one hundred and forty-eight telephone companies in the United States, which numbers have, since that time, been greatly increased by the more general introduction of the system of telephonic communication and the incorporation of many electric-light companies, to say nothing of an increase in telegraphic associations. The single wire from Washington to Baltimore had increased in 1880 to 325,517 miles of wire, 34,305 of which were operated by the telephone companies, and in October, 1883, one company alone, the Western Union, was operating 432,726 miles of wire, nearly enough to reach from the earth to the moon and back again. This same company in 1866 used only 75,686 miles of wire, so that it will be seen it has nearly six times as much wire strung over the country as it had then, and these 432,726 miles of wire are exclusive of 144,294 miles of cables and poles. Of the latter ungainly commodity it set up, in the year 1880 alone, 168,056, which is about two thirds of all the poles erected that year.

The magnitude of these figures is by no means wholly due to the extension of lines in newly developed portions of the country. The growth has taken place in cities as well. In New York city, for instance, there are now twenty-five public telegraph and four telephone companies, to say nothing of electric-light organizations and private parties using wires. Their operations are conducted in two hundred and eighty-five offices, allowing only one office to each telephone company. But, as each telephonic subscriber requires a separate instrument, there are, practically, as many offices as subscribers, and the above number must be increased by several thousands. As each of these thousands of telegraphic and telephonic offices has from one to several hundred wires running from it to some other point, one realizes what a gigantic net-work of wires has been woven over us ; and, when we add the testimony of the senses, the stupendousness of the encroachment becomes still more apparent. From roofs of private buildings and from poles in public streets the meshes depend, each pole strung with from to one to one hundred and sixty or even more wires. At the corner of Wall and Water Streets, for instance, is a pole with one hundred and ninety-six insulating points. Be these public ways wide or narrow matters not, so far as encroachment is concerned. Some of the largest poles have been erected in the narrowest ways. In Fulton Street, west of Broadway, for example, there are poles seventy-eight inches in circumference. In other places poles sixty and sixty-four inches in circumference have been placed, and a diameter of a foot and a half is common.

Now, all these facts and figures bear startling testimony to the extent to which a system of encroachment upon public and private rights may silently proceed when unchecked. When to this thought we add a recollection of the instances of danger, obstruction, and accident occasioned to life, limb, and property by wires and poles, it must be admitted that a system, whose benefits can hardly be overestimated, has nevertheless become, through an utter disregard of the changed conditions brought about by time, obnoxious in its operation. In the language of modern thought, it has failed to adjust itself to its changed external relations. It is out of correspondence with its environment. This want of correspondence in the case of a human being is called death. In the case of the system under discussion, instinct has taught the layman to call it a public nuisance, which, if so, is theoretically about the same thing as death, inasmuch as, in the eye of the law, that which is a public nuisance has forfeited the right to exist. That this lay opinion is right and that the system is, *per se,* a public nuisance, is a matter of elementary law.

How comes it, then, that such a condition of things has arisen? Ask the offending corporations, and they will tell you that it is a *legalized* nuisance, and point to legislative enactments which they claim legalize their acts. It becomes necessary, then, to examine these enactments. In a magazine article it is of course impossible to review the laws of all the States. We propose to confine ourselves, therefore, to those affecting New York city, which is the longest-suffering and most interested of our municipalities.

The Legislature of the State of New York, in 1848, authorized the incorporation of companies for the purpose of constructing a line of wires of telegraph through the State, from and to any point within it. This was the franchise, and it was given upon certain terms, conditions, and liabilities. Lines of telegraph might be constructed along and upon any of the public roads and highways, or across any of the waters within the limits of the State, by the erection of the *necessary* fixtures, including posts, piers, or abutments for sustaining the cords or wires of such lines, *provided* the same were not constructed so as to incommode the public use of the roads or highways or injuriously interrupt the navigation of the waters. By a subsequent act, in 1853, it was provided that any number of persons might associate for the purpose of owning or constructing, using and maintaining a line or lines of electric telegraph, whether wholly within or partly beyond the limits of the State, or for the purpose of owning any interest in such line or lines of electric telegraph or any grants therefor, upon such terms and conditions and subject to such liabilities as were prescribed in the act of 1848. Such association was authorized to erect and construct from time to time the *necessary* fixtures for such lines of telegraph, upon, over, or under any of the public roads, streets, and highways, and through, across, or under any of the waters within the limits of the State, subject to the restrictions contained in the act of 1848.

It is under these acts that the evil we complain of has principally arisen. With regard to the exceptions, as, for instance, the electric-light companies, although the language of the statutes authorizing their creation is in some respects different, the principles laid down in this article are, in the main, so far applicable that the same general conclusions are deducible. For the same reason, therefore, that led us to avoid a general review of all the State laws, no separate discussion on this point will be instituted.

It will be observed that, in the legislative acts cited, unqualified power as to the methods of exercising the franchise is not given. The companies are, in effect, prohibited from erecting any fixtures except those which are necessary, and, whether necessary or not, the land-fixtures must not incommode the public use of the streets. Any unnecessary or incommoding fixtures still remain an unlegalized public nuisance. Are, then, the wires and posts necessary, as at present erected? Do they incommode the public use of the streets?

Take the latter question first. When a street is laid out and opened, all persons acquire the right to use it, to pass and repass at their pleasure *on any part* and in such direction as may suit individual convenience and taste.* This is what is meant by the public use of a street. Now, the right of the public to use the public streets freely and in every part can not well be exercised when poles occupy a portion of the land. If what is called "the fourth dimension of matter" were a reality, a person might be able to pass through the pole without disadvan-

* Allen's "Telegraph Cases," p. 139.

tage to himself or the pole, but "the fourth dimension" is not as yet a demonstrated fact, and without it the space occupied by the poles is withdrawn from the public use. The fact that sufficient space remains for public traffic is immaterial.* The public use of the streets is therefore disturbed and inconvenienced, or, in other words, *is* incommoded. This, unfortunately, is not the full extent of the disturbance. To illustrate:

That man should be protected in the enjoyment of life, limb, and property is recognized in every system of law. That the fire department is a potent instrument in such protection goes without saying. That its occupancy of the streets, with its paraphernalia of safety and protection, is a proper public use of the streets, none will gainsay; and that the fullest facilities should be afforded it for the untrammeled exercise of its protective powers is self-evident. Now, a New York city fire-department official recently stated that the firemen are delayed at almost every fire in raising ladders by the wires which are strung in front of the houses. He considers them a very serious obstruction, and adds that if there were no telegraph-wires strung through the streets the fire department could raise a much longer ladder than they do at present. Serious difficulty, he continued, is met with in fighting fires from the outside of buildings, on account of the wires, which make a net-work in front so strong that it is impossible to force the water through it. Poles, too, are in some instances placed so close to hydrants as to interfere with the firemen's work. This being so, how can it be denied that the public use—and a very important public use—of the streets is seriously interfered with and incommoded? Must it not, then, be admitted that, measured by one of the tests of legality, the overground system falls short of the requirements necessary to bring it within the pale of protective legislation, and must still be adjudged an unlegalized public nuisance?

How does it stand the other test prescribed by the Legislature? Are poles and over-ground wires *necessary* fixtures in cities? The companies contend that the statutes expressly authorize the erection of posts and wires. Is this so? The act of 1848 (which, if not supplanted by the act of 1853, is the only one which refers to posts) authorized the erection of the *necessary* fixtures, including posts, piers, or abutments. The only permission given is to erect such fixtures, including posts, piers, or abutments, as are necessary. Only by doing violence to the English language can the words be interpreted otherwise. The construction placed upon them by the companies, followed out, leads to an absurdity. If, as they claim, there is unlimited authority to erect poles in the streets whether necessary or not, there is exactly the same authority to erect, *in the streets*, piers and abutments. But it is plain that such erections were never intended to be made in the streets, and no company would claim it. The fallacy lies in confound-

* Allen's "Telegraph Cases," p. 180.

ing the franchise, which is to construct lines, with the method of its exercise. The two are distinct. The former is absolute ; the latter is conditioned. None can dispute the right to construct lines, but *how* it shall be done depends upon what is necessary. Piers and abutments may be necessary in certain places, and posts in others. When necessary they may become lawful ; but neither piers, abutments, nor posts are lawful erections where they are unnecessary. This is a fair construction of the language used.

Are posts, then, necessary to the enjoyment of the franchise of the telegraphic companies in cities ? That depends upon whether there is any other practicable way of exercising the franchise which is less of a nuisance, for the franchise must be exercised, in crowded cities, at least, in such manner as to obviate the nuisance, if possible, and inflict the least injury upon others, the best means to that end being employed, and, if there are two ways in which a franchise can be exercised, one of which would create a nuisance and the other would not, or would at least diminish it, that method must be adopted which will obviate the nuisance, or reduce it to a minimum. Otherwise, the act becomes unlawful for exceeding the limits within which obstructions are allowed in the interests of the public.*

Now, it is well known that there is, besides the overground system, an underground method of constructing lines. The latter, manifestly, does not permanently obstruct the streets, or incommode the public use of them. In fact, the courts have decided that it is not in fact or in law a nuisance.† Moreover, under this system, the exercise of the franchise is very unlikely to result in injury to person or property. If this system is practicable, the telegraphic companies must, in view of the principles applicable to their case, adopt that method. For, if the pole system is a nuisance, and the underground way is not ; or, if the former permanently obstructs the streets, and the latter does not ; or, if the pole system is dangerous to life, limb, and property, and the underground plan is not, or is less so—then, so long as the poles are left standing, and the wires strung, the franchise is not exercised in such manner as to reduce the nuisance to a minimum, and to inflict the least injury upon others, and the corporate acts are unprotected by law.

The question of necessity resolves itself, then, into a question of the practicability of the underground system. There are many who claim it to be impracticable, and, as a matter of course, there are imperfections in the system, in which respect the overground method is like it. But to all that may be said against it, there is one indisputable reply, that subterranean wires are serving their purposes successfully in various parts of the world to-day. The system is successful in London ; also in Paris, and other European cities. Miles of wire have been successfully operated in Washington. An underground system has been tried with success in Philadelphia. It has worked well in

* § 60, N. Y., 510.

† Allen's "Telegraph Cases," p. 173.

other cities; and, finally, *for its own convenience*, the Western Union Company has several miles of wire underground in New York city, which are also operated successfully. When to these undisputed facts we add that such a practical genius as Edison has declared that *there is no reason whatever why all wires operating electrical apparatus should not be underground*, except expense, which in the eye of the law is no excuse, there is sufficient demonstration of the practicability of the system for the purposes of this article. Unless such evidence can be rebutted, the companies are guilty of erecting, in the exercise of their franchise, unnecessary and therefore unlawful fixtures.

If unlawful, within the meaning of the legislative enactments, no aldermanic sanction can save them; for the stream can not rise higher than its source. Permission by the Common Council, if inconsistent with the law of the State, is wholly void, and, even if this were not the case, it is questionable whether the Common Council of the city has power to consent to the erection of a single pole. The charter gives it power to regulate the use of poles in streets, but the power to regulate a nuisance is not the power to create one. This becomes more apparent taken in connection with the prohibitive side of the charter, by which the Common Council is forbidden to permit *any* encroachment upon or obstruction of the streets, except the temporary occupation thereof during the erection or repair of a building on a lot opposite the same. Now, this either means something or nothing, and, with the principles in regard to legalizing nuisances in mind, we are inclined to believe it means all that we claim.

Before leaving this point, it may be added that, even if there were no such thing as an underground system, it is quite probable that most of the poles now standing would have to be condemned as nuisances; for, if smaller poles of the same or another material, such as iron, would answer the same purpose, the obstruction as it now exists is not reduced to a minimum, and, under the principles of which we have spoken, are therefore unlawful. That smaller poles would do, is, we think, capable of demonstration, but it is not necessary to enter upon a discussion of this matter, as our objections are aimed at the overground system as a whole.

To the reasons we have thus far given why the poles and wires should come down, there may be added another reason. Recent elevated-railway litigation has made the public more or less familiar with certain principles of law regarding the use of streets by private corporations. Whether the fee of a street is owned by the abutting owners, or has been taken by the public, but in trust to be used as a public street, no structure upon the street can be authorized that is inconsistent with the continued use of the same as an *open* public street, without compensation to the abutting owners, who are entitled to use it.* Measured by this principle, there is no difference between an elevated-

* 90 N. Y., 122; 91 N. Y., 153.

railway structure and a telegraph-pole. Both are uses of the street inconsistent with the use of the same as an open public street. Such use in both cases violates the rights of abutting owners to freely use or pass over the street. How, then, has a single post been legally erected, if the owner of the premises, whose rights are violated by the erections in front of his property, has not *first* received compensation, be it ever so little, awarded him in due form? It is safe to assume that not one cent has ever been paid by way of such compensation, and, that being the case, such structures must fall under the prohibition of the above principle, and are therefore unlawful.

But, if, after all, none of the foregoing objections are tenable, is there no way of getting rid of the evil? If a panacea does not already exist, one suggests itself in legislation. Our State Legislature can relieve us. It has the power to drive the poles and wires from the street, and compel the construction of lines underground. As to wires yet unstrung and poles yet unerected, it may be said this course would be quite proper, but with regard to those already up (assuming that they are legally up) would not such legislation be manifestly unconstitutional, as impairing the obligation of the charter contract which, we will say, authorized their erection?

Now, the framers of the Constitution, in declaring against the enactment of laws impairing the obligations of contracts, never intended that the Legislature should altogether avoid retrospective action upon the civil relations of parties to existing contracts. No Legislature ever did avoid it, they said, and to require it would be extremely inconvenient.* It has accordingly frequently been held by our courts that the clause in question does not so far remove from State control the rights and properties which depend for their existence or enforcement upon contracts as to relieve them from the operation of such general regulations for the good government of the State and the protection of the rights of individuals as may be deemed important. † All enactments are subject to the subsequent exercise by the Legislature of what is known as the police power, which the Legislature can not alienate, if it would, but must reserve to itself in order to avoid embarrassment in the exercise of control over the general welfare. By virtue of this power the Legislature may, for the public welfare, subject persons and property to various restraints and burdens. It may abate nuisances, even if in their origin they may have been permitted or licensed by law. It would be monstrous if it were otherwise. If a charter implies that a corporation may always continue to exercise its rights in the same way in which their exercise was at first permissible, and under the regulations then existing and those only, the public would be helpless when, without anybody's fault, circumstances so change that what was once lawful, proper, and unobjectionable, be-

* Cooley's "Constitutional Limitations," p. 716.

† Curtis's "History," vol. ii, p. 367.

comes a public nuisance, endangering the public health or the public safety. As circumstances change, regulations affecting the exercise of a franchise may be changed, too. "It can not be," said the Court in one case, "that the mere form of the grant should prevent the use to which it is limited being regarded and treated as a nuisance *when it becomes so* in fact." * In that case, as in many others, the exercise of the police power was held constitutional, even though it directly violated rights theretofore given. By this power the removal of mill-dams once lawfully erected has been compelled, and railroads have been obliged to adopt devices for safety not prescribed in their original charters, even though it caused expense. That is not a matter to be considered when a question of public safety is concerned. Then why should this power not be resorted to in the case of telegraphic and electrical obstructions? Are they exceptions to the rule that when under changed circumstances lawful erections become nuisances they may be abated? We think not. The police power ought to be exercised. Legislation, by virtue of it, driving the wires underground and the poles from sight, would, we submit, be in every respect constitutional and proper.

Such legislation might take the form of direct enactments against the evil, or of a delegation of authority to act in the matter to municipalities. While the police power can not be alienated, it may be delegated to a municipality; for one of the objects of the creation of municipalities is to exercise certain powers of the State in localities. In New York city, it may be that, in the right to regulate the use of streets for poles, the local legislative body has been already clothed with this power sufficiently to meet the evil. Be that as it may, the point remains the same, that the evil is to be met by legislation. Whether by the principal directly, or indirectly by its agent, matters not, so far as its propriety or constitutionality is concerned.

If we are right in our conclusions in this article, why should the evil be allowed longer to exist? Is the corporate power greater than the influence of public opinion? Or, if so, shall public opinion be left unsupported by concerted action? As in politics, or almost any other sphere of action where many are concerned, so, in the suppression of this evil, much depends upon the part taken and the activity displayed by the individual. Those who put forth no exertion to save their rights and tranquilly sleep on them need not be surprised if their rights are trampled upon.

* Cowen (N. Y.), 605.

STETHOSCOPY.

By SAMUEL HART, M.D.

ONE fifth of the adult population of Christendom is suffering from chest or thoracic diseases of a degree varying from the insignificant to the most grave; while another fifth is living in constant fear of being or becoming their victims.

In fact, diseases of the lungs and heart far exceed those of any other class in prevalence and fatality—consumption, so called, causing one fourth of the mortality between the ages of seventeen and thirty-five years—while diseases of the heart are of well-known formidable character, and raise the proportion of thoracic or pectoral diseases to a surprising ratio.

The study of this subject, as regards the causes and preventives, the symptoms and cure, has received the diligent attention of scientists and sanitarians as well as of physicians.

Leaving to the physician his subject in its multiple and exhaustless forms, I propose in this paper to give some account of the practical diagnosis, or methods of determining the nature, exact locality, and extent of thoracic disease, by means of stethoscopy, or the physical exploration of the chest.

The thorax incloses the essentially vital organs—the lungs with their pleuræ, or delicate membranous coverings, and the heart with its pericardium and great blood-vessels. These, actuated through their system of nerve-filaments, give the rhythmic heavings of respiration and the throb and pulses of the blood-circulation.

Although so admirably guarded against harm by the strong and elastic chest-walls, and against all inimical approach by that ever-vigilant sentinel, the epiglottis, they are, from the very nature of their functions, pre-eminently subject to danger from without as well as from within. The delicate mechanism of living lung-tissue can not be subjected to direct observation; the minute cells for containing air would be crushed by air admitted from without, and the heart arrested for a moment for inspection would never beat again; yet the vital operations of these organs are well understood and their morbid conditions can be read almost as if exposed to view.

On firmly applying the ear to the walls of the chest of a person in health, certain sounds can be heard, varying in loudness and clearness with the quarter of the chest at which the ear is applied, and with the age or individual peculiarity of the person examined, or his state of action or repose. The double sound of the heart, embracing what are known as the first and second sounds, is heard distinctly: the former caused by the strong muscular contractions of the ventricles, mainly the left, whose function it is to distribute the blood to the system.

This contraction causes the pulse, with its many qualities of quick or slow, soft or hard, regular or intermittent, and others which furnish to the *tactus eruditus* valuable indications of the physical condition not only of the heart itself, but also of the system at large.

The sounds of respiration are also heard: the inflation of healthy air-cells, producing the *vesicular murmur*, is audible even to the unaided ear.

This direct application of the ear to the chest (called *immediate auscultation*) is preferred by some as having advantages over the *mediate* or instrumental method. The former is, however, open to some objections which are readily apparent, both as regards the subject and the examiner; while the stethoscopic method possesses numerous advantages, without the objections.

The following is a brief description of the appliances ordinarily in use in exploring the thoracic contents:

First in importance among these is the *stethoscope* (Fig. 1). This instrument, in its primitive form, was exceedingly simple: at first a cylinder of paper, rolled tightly and of convenient length. A ready substitute was found in wood; and this was carved or turned to give lightness and to improve appearance. Cedar and ebony have been preferred, as being of fine quality and easily polished. Vulcanite and

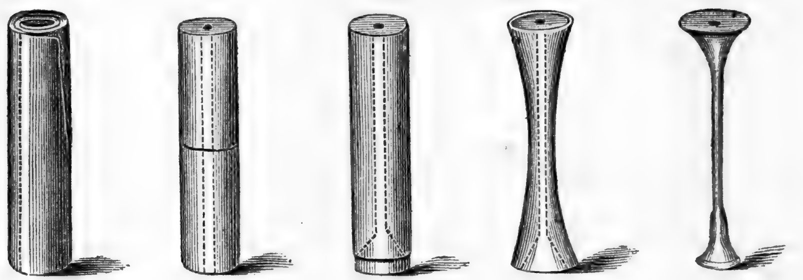

FIG. 1.

various metals are also used, made in similar form—i. e., a tube of suitable length, expanded at one end into a hollow cone for application to the chest, and suited at the other end to the rim or opening of the ear. In these as in all other forms the object is to insure, when in use, a confined column of air extending from the bare walls of the chest of the person examined to the ear of the listener; and upon the completeness of the adjustment and consequent inclosure of the air depends the efficiency of the instrument, since the confined air—not the instrument—is the medium of conduction of the sounds.

The *flexible tube* was used later as a step in stethoscopic evolution, which gives the advantage of allowing comfortable respiration without disturbing the inclosed air of the tube by the movements of breathing, which tend to press the instrument alternately against the ear of the listener (Fig. 2).

The *binaural stethoscope* (Fig. 3) of Dr. Camman, of New York city, is unquestionably the best instrument known. Its name signifies its peculiar advantages. Two tubes (one for each ear), suitably curved,

FIG. 2.

and each furnished with a rounded bulb for accurate fitting to the opening of the ear, are connected at the other ends with a hollow cone for application to the chest of the person examined. The cones or chest-pieces are of various sizes, and are adjusted and used interchangeably according to the required extent of field which has its limits between one and two inches in diameter. They are made from ebonized wood, vulcanite, or soft rubber, the latter being required to

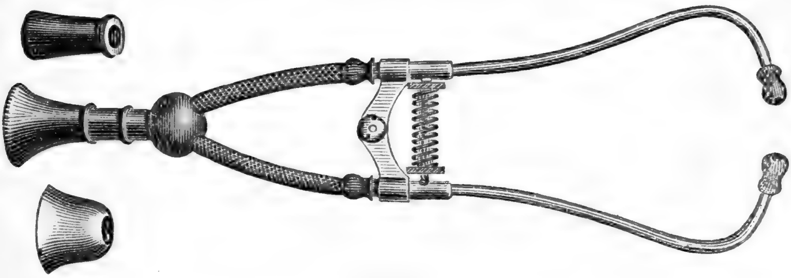

FIG. 3.

prevent painful pressure on uneven surfaces of the chest. In a part of their course the tubes are elastic, the remainder being metallic. They are so constructed as to be easily and perfectly adjustable to the ears by softly elastic springs. By this arrangement both ears are not only equally engaged with the same sounds, but other sounds are practically excluded. This feature is fairly represented in the binocular microscope and in the stereoscope, which possess the full advantages derived from the use of both eyes. Thus the stethoscope heightens and places in relief our auditory perception of the movements and conditions of deep-seated vital organs, giving prominence to the lines and shades of a picture otherwise flat and indistinct. It will, of course, conduct all sounds communicated to it from without, thus making it necessary to avoid all frictional contact with the instrument, even of the lightest clothing; and the listener will steady it deftly by thumb and finger to escape confusion from a multiplicity of sounds. By the practiced ear, however, most of the numerous adventitious sounds can readily be eliminated and the attention successfully fixed on the one sought.

The means next in importance in questioning the condition within the thoracic cavity is *percussion*. It consists in striking upon the chest with carefully-suited force with the tips of one or more of the fingers slightly bent; or with a light elastic hammer called the *percussor* (Fig. 4). The finger of the other hand or a solid, flattened disk, the *pleximeter*, must be held firmly against the chest to receive the stroke and to educe the proper resonance. The percussion-sound, though apparently unmusical, must have its intensity, be high or low, and have its peculiar *timbre*—all requiring acuteness of hearing and judgment in interpretation.

The *spirometer* is of use for measuring in cubic inches the maxi-

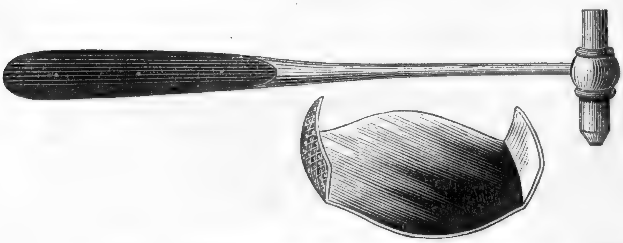

Fig. 4.—Flint's Percussor and Pleximeter.

mum amount of respirable air, of which each individual has his normal quantity, but which is subject to changes from organic affections of the lungs.

The *cyrtometer* is used for delineating the external contour of the chest and for exact comparison of one side with the other.

Numerous other instruments are of real utility, only one of which, however, will be mentioned.

The *sphygmograph* is an instrument of somewhat complicated mechanism. It is used to "feel the pulse" and to record its impressions. It will give its frequency and rhythm, its varying tension and strength, the condition of the heart and certain valves, with a delicacy and exactitude which, compared with the results obtainable by the most sensitive finger, are like the perfect work of photography compared with the attempts of the juvenile charcoal artist. With its touch upon the heart or its vessels, and its pen apparently in sympathy and vital connection with them it will record in delicate but infallible tracery the diagnosis, and mayhap the prognosis, of the subject under examination, which may be read with trembling expectation.

In this instrument the impulse of the blood-movements is communicated to the pen by water contained in flexible tubes. The oblong receptacle, also containing water, is connected with one of these tubes. It has on one side an elastic projection which is to be securely fixed upon the pulse to be examined. All vibrations received by it are transmitted by the water through the tube to the chamber. On the upper surface of the chamber is a delicate membrane which receives the vibrations with every requisite as to quality and exactitude. The movement of its wave is, however, microscopic, and, in order to render it visible and legible, an exceedingly light and sensitive lever terminating in a pen is so placed in contact with the membrane as to amplify manifold in tracings the movement it receives. The inscription is received on a slip of smoked glass, which is made to move before the pen with precision by a mechanism which also acts as the chronograph, indicating the time at the lower edge of the glass in seconds and

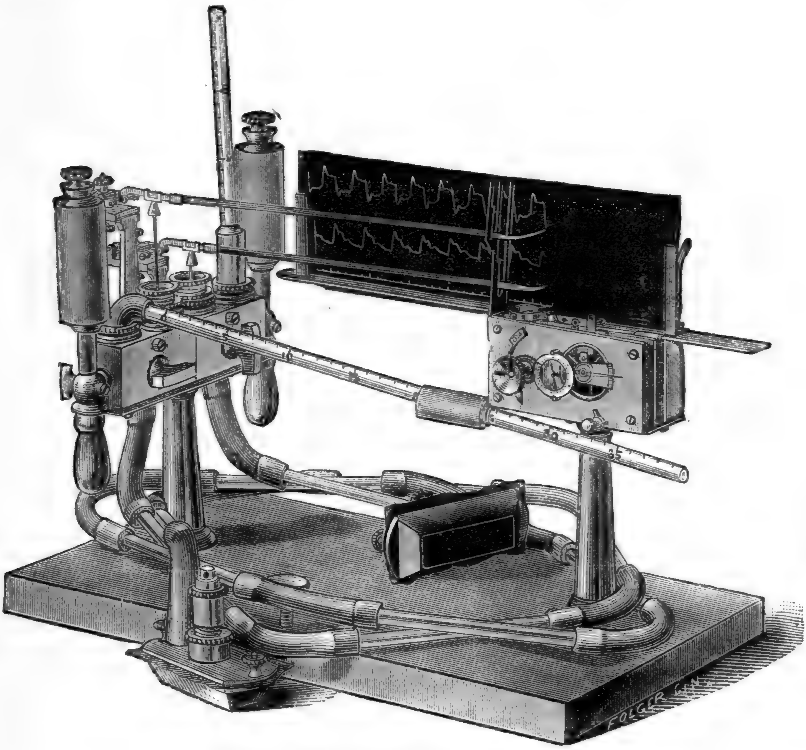

FIG. 5.—KEYT'S COMPOUND SPHYGMOGRAPH.

fifths. A second pen with similar connection is made to trace on the same slide the movement of another pulse at a distant part of the system.

Space will not permit of reference to the numerous and important accessory contrivances of the complete instrument, nor to the numerous indicatory marks on the following cuts. To the specialist they are significant and essential. Simultaneous tracings of the heart and a large blood-vessel of the neck are shown below (Fig. 6). It should be explained that the upward stroke in the tracing answers to the heart-beat; the downward stroke and succeeding wavelets indicate the recoil of the blood and the tension of the vessels; while the whole cycle with its chronometric line below furnishes a wonderful map.

This graphic method includes cardiography, in which a tracing is obtained of the pulsations of the heart, and pneumography, in which are recorded the movements of respiration. It includes also the multiple simultaneous method, in which two or more vital movements—for instance, of the heart, pulse, and respiration—are recorded at the same time, showing their exact relations to each other. The sphygmograph, in the compound form of Dr. Keyt (Fig. 5), with a chrono-

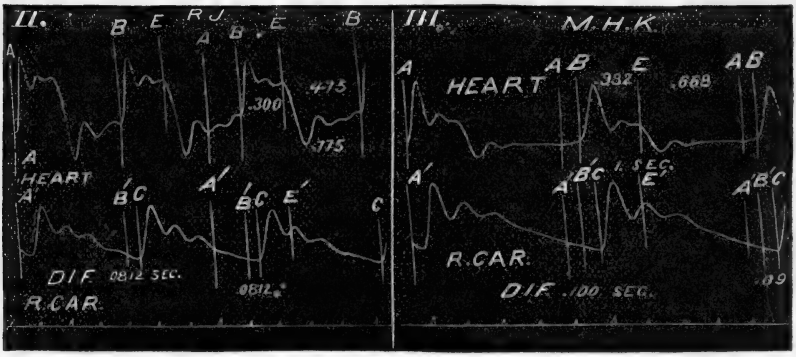

Fig. 6.

graphic attachment, is a modern mechanical help in stethoscopy of great value, and has given important light on questions of physiology and pathology. It is an instrument of precision, of scientific interest and importance, and in difficult physical explorations the graphic method is found almost indispensable.

A few cases will now be given illustrative of practice in stethoscopy. A patient has the following symptoms: "Shortness of breath, smotherings, cough with little expectoration, pain of the side, varying from the sharp stitch to the dull and aching pain." The illness and distress are evident, and though the question of present relief is uppermost in the patient's mind, he has sufficient intelligence to demand and to comprehend the *cause.* From the symptoms given it may with about equally reasonable grounds be supposed that the trouble depends upon organic changes of the heart, its valves, or its pericardium; of the lungs or their pleuræ; or upon disturbances not directly connected with these organs at all, but arising from impressions transmitted through the reflex system of nerves; or it may be owing to a combination of two or more of these causes.

No amount of experience or tact will enable the physician to do more than to guess the diagnosis from these symptoms. He is unable to prescribe intelligently the needed means of relief and of the expected cure except by means of physical exploration of the chest. On inspection, increased frequency of breathing is observed: this is a suggestion only.

On applying the stethoscope the heart is found somewhat displaced, but perfectly healthy as regards its size, its valves, its membranous coverings—an important step by way of exclusion of certain possible conditions.

The whole of the left lung is found performing its functions healthfully. Nor is any disease found in the upper portion of the right lung; but, on searching the lower two thirds of this side, there is found an entire absence of all sounds of respiration; and, under percussion, no normal resonance due to the presence of spongy lung-tissue is heard—the sound is *non-resonant.* A partial resonance would be *dullness;* in this case it is "*flat.*"

These data prove the absence of all healthy lung-tissue in the lower two thirds of the right side of the chest. What, then, occupies this region? The lung solidified by morbid changes may be there; or it may be displaced by a tumor, or by fluids; and each of these morbid conditions has nearly the indications mentioned. On carefully examining the upper limit of flatness of sound, while the patient is sitting or standing, it is found to extend exactly horizontally around the chest. Next, requiring the patient to recline backward, the physician finds the boundary-line of flatness to have changed to two or three inches lower on the front, while upon the back of the chest it will be higher than before; yet the line is still strictly horizontal.

The significance of this test is that, though the chest has changed its position, its movable contents, obeying their physical law, tend to preserve a horizontal surface.

Certain complications may prevent the availability of this "hydrostatic test"; but when found it is infallible, and in this case excludes all of the supposed conditions.

The diagnosis now is, that the right lung has been compressed into a narrow compass in the upper part of the chest by the gradual accumulation of from thirty to forty ounces of fluid; and this fluid has also so encroached upon the heart as to cause some displacement and to embarrass its action as well as that of the left lung. These conditions account fully for the symptoms mentioned, and for the distress of the patient.

Negatives, exclusions, and probabilities alone are inadmissible; a *diagnosis* is required. The examiner may not *guess* from the symptoms; his tests must be objective, and as positive as the laws of physics. They must not fail, for the life of his patient is at stake; and the treatment to follow will prove his skill, or, may be, his fatal error. If a small hollow needle be pressed through the chest-walls into the suspected region, the outpouring fluid will bring the needed relief and will verify the predictions of the ear by actual sight, weight, and measurement. This case is one of no uncommon occurrence, the treatment almost painless, and very satisfactory as to present relief and the prospect of permanent cure; the lung may expand to its normal size, and resume its functions healthfully. And the case is one requiring only the ordinary and easier means of diagnosis.

The acutest ear and the most practiced discernment are required in meeting the difficulties arising from complications of diseases, and the absence of those sounds and changes which are sufficiently distinct and characteristic—a condition to be expected in all earlier stages of pectoral troubles.

A life-insurance agent brings to his company's medical examiner an individual whom he considers an exceptionally "good risk." He has the facial appearance, the physique, and record of perfect health. The examiner, in making up the rigid descriptive list for his company, must assure them, as "parties of the first part," that in this case the sounds of the heart are perfectly natural; that its movements are entirely correct as regards their rhythm, strength, and frequency; that the pulse does *not* intermit, etc.; and that there is no disease or morbid condition, or tendency thereto. Tested by the spirometer, the applicant is found to breathe easily the amount of air known to be the average for persons of his size (more strictly, height). By the usual tests of auscultation nothing is found wrong. On a more scrutinizing review of the case, as becomes the faithful officer who is to be the impartial judge on the trial, a small area is found near the upper portion of one lung where, by percussion, the normal resonance has given place to a degree of dullness—a sound which signifies the half-way limit between the resonance of perfect health and the "flatness" of advanced change.

This quality of sound would pass unobserved, except for easy comparison with the adjacent portion of the same lung, and with the corresponding part of the opposite one. The dullness is found to be better shown by light percussion than by more forcible strokes—an indication of the superficial situation of the changed tissue.

On again applying the stethoscope over the region, the natural vesicular quality of the inspiratory murmur is found to be changed to the broncho-vesicular murmur—indicating partial solidification of lung, which, if more complete, would give the bronchial or tubular sound. The pitch of its tone is raised, and it is "rough" or "harsh." A sound of *expiration* is also heard *distinctly*, while normally it is barely audible.

There are now three facts which tend to becloud the otherwise good record of the case.

A further test may be made by auscultation of the applicant's voice. On applying the stethoscope upon the place mentioned, the subject is required to speak or count in his ordinary tone of voice. There will be heard sounds apparently near the ear, approaching in distinctness to words—not articulate, as would be heard in complete solidification, but easily distinguished from the distant jarring sound of a healthy lung, called vocal fremitus.

The applicant has now through his own honest voice given adverse testimony. Try next whether he shall *whisper* a confirmation of the same unfavorable story. The whispering voice heard through solidified lung-tissue is increased in intensity and raised in pitch, which, discouraging symptoms being found in this case, may suffice although further tests are available.

There are now five witnesses, each of whose testimony is more than "circumstantial"; collectively they agree perfectly and are invariably truthful.

The following decision must be rendered: The applicant is in possession of health so good, and a record so favorable, that he has probably made his application for life-insurance in all fairness, but, subjected to the company's exact tests, he is debarred. He must be rejected on the ground of organic pulmonary lesion. A portion of one of his lungs is by some morbid process changed from its delicate, spongy structure to one which is more solid; the air-vesicles have been encroached upon by material which not only has interfered with their functions (though inappreciably to himself), but which may prove a progressive and fatal invasion.

This case is one of a numerous and highly important class—an individual in fair health, without symptoms of any disease, is, by the stethoscopic ordeal, accounted a "bad risk," or is denied the advantages of assurance, and informed that some hygienic or curative course is essential for his safety.

On the other hand it may be stated that, without multiplying illustrations, there are very numerous instances in which the subjective indications (symptoms) of organic disease are so prominent and the distress so urgent as to appear conclusive proof of imminent danger. A test of a few moments' time will make the correct diagnosis and furnish a comforting stethoscopic negative.

Disorders of the heart, although of less frequent occurrence than those of the lungs, are of equal importance and require the best skill of the examiner.

In searching for its disordered conditions it is necessary to keep in mind the anatomical features of the organ. As a piece of mechanism it is a pump, constructed of pliant, fleshy walls; it has four chambers with numerous valves, and its columnæ and chordæ. Protected from friction and abrasion by the constantly renewed fluid within its strong membranous incasement, it expends an incredible amount of force in its incessant and exclusive work of propelling the blood. But it must also be considered as a *sensitive center* with an apparently independent vitality, in direct communication, through its web-work of nerves of the sympathetic system, with every organ and tissue of the body, according to whose demands, as well as to the varying activities of the brain, it regulates its movements.

The manner of this response is frequently so energetic and tumultuous as to cause much mental disquietude, if not real physical distress, and to furnish the well-known question, whether there be "functional or organic disease."

Its vigorous impulsion, its notable sounds, and its location near the chest-walls, render a study of the condition of the heart entirely practicable by stethoscopic auscultation. By this method its size, its location, and the state of each of its valves can be learned with much precision.

The heart-sounds are sufficiently loud and distinct to be susceptible of much exactitude of description and characterization. The contraction of the ventricles, which mainly produces the "first sound," is the exertion of a force equal to the grasp of a strong hand; it is forcible and quick, but its time as represented by its sound is measurable. This sound is composed of two elements—one of propulsion, with a "booming" quality which is the characteristic, and one of valvular, or sudden clicking sound. Its rhythm, as observed in its succession, is trochaic.

The "second sound" is principally caused by the sudden arrest by the semi-lunar valves, of the column of blood in its tendency to return to the heart under the elastic recoil of the arteries after their forcible distention. It is quick and valvular; it is higher in pitch than the first sound and its rhythm is iambic.

Each of these sounds is more or less ringing and clear and has its appropriate *timbre*.

After an almost imperceptible interval, the "first sound" is followed by the "second," then by a rest; the whole cycle occupying about one second of time. Its divisions may be represented as follows: first sound, $\frac{4}{10}$; second sound, $\frac{3}{10}$; rest, $\frac{3}{10}$. Each has its exact normal place of greatest intensity and perfection, relative to the external topography of the chest, and variations from this rule will be an index of change of structure within the heart itself, or of displacement from malformations or morbid conditions of the adjacent organs.

It is convenient to designate as *heart-sounds* those sounds which are normal, and as *heart-murmurs* those sounds which are adventitious and, as a rule, indicative of organic changes.

The murmurs are of peculiar character, of great variety, and usually of important significance. They originate either within the heart (endocardial) from defective valves or obstructed orifices, or else without it (exocardial) from friction against morbid accumulations within its membranous envelope; or, finally, though exceptionally, they are found to depend upon certain conditions of the blood.

The murmurs are very numerous and variable, and difficult of description according to any rules of rhythmics, melodics, or dynamics; as will be seen from the following names applied to them—and these only a fraction of the whole list: sawing, rasping, scratching, scraping, grinding, creaking, rubbing, churning, blowing, whistling, cooing, purring. And, as if from poverty of language, fashion or necessity has led to borrowing from abroad; as *frémissement cataire, bruit de souffle, bruit de scie*, etc. The terms in use should through some conventionality be revised. Many of them, however, are practicably indispensable and fairly expressive of sounds actually and distinctly heard, for which a verbal rendering is necessary.

The loudness and clearness of the murmurs are by no means proportionally indicative of their gravity; since one barely audible may from its location and character be a low premonition of mischief, while a more demonstrative one may have no important significance.

In a rare case, a musical murmur was heard exactly resembling the notes of the cuckoo; it was so loud as not to be the exclusive property of stethoscopists, for it could be heard at a distance of several feet. Moreover, it was shown by the "demonstrator," *post longam vitam*, that the heart whence the sound had proceeded was entirely free from all organic disease.

The mechanism concerned and the method of determining the kind and location of a murmur may be referred to very briefly.

As an example, organic disorder of the aortic semilunar valve will be presumed. Imperfections of this valve are among the more frequent diseases of circulation, and are of import more or less serious according to their extent; its total failure nullifies every anatomical perfection in all the other organs of circulation.

With the stethoscope suitably placed, a distinctly audible murmur will be detected. On observing the rhythmic succession of "first" and "second" sounds the murmur will be found to occur exactly with or in place of the latter, whose sudden click will at least be notably weakened. The murmur is found over the position of the semi-lunar valve and extending downward in a line toward the middle of the chest; it is slightly prolonged after the "second sound." No other murmurs are discovered. These are sufficient data for a diagnosis.

The observer has seen, as it were, two ounces of blood destined for the wants of the system driven through the semilunar gateway into the great vessels; this movement was accompanied by the normal booming "first sound" and was attended by no murmur. There was, then, no obstruction or narrowing of the orifice, nor roughness of the valve, that by consequent vibrations could produce a murmur. But the observer has seen the measure of blood, under the elastic pressure of the vessels, returned upon the semilunar valve for momentary support, where, instead of being promptly arrested by the three-winged leaflets, a portion passed between their narrowed or irregular edges into the heart, and at this instant of regurgitation the murmur was heard. The blood could flow unobstructedly from the heart, but its unfavorable retroversion was made possible by the organic imperfection called *insufficiency* of the semilunar valve of the aorta.

The sphygmograph alone would have written the above diagnosis in this uncomplicated case with entire completeness, and its tracings would have shown also, as a part of the pathological history, that the valvular defect originated many months ago; that, through the natural curative processes the heart had gradually increased in strength until full compensation for the defect had been reached; and that, with the growth of strength there had been corresponding enlargement, which, instead of being a morbid condition, however, is in this instance really conservative and favorable.

While stethoscopy possesses an interest amounting to fascination, from its vital importance, from the numerous difficulties which can be overcome by reasonable diligence, and from the great degree of exactitude on the whole attainable, it still has its difficulties intrinsic and its difficulties of circumstance. In its practice observations must be made principally through the single sense of hearing; for, practically, the organs which are within the range of a whisper are to the other senses as distant as the antipodes.

There are difficulties from within the chest, from overpowering abnormal sounds, as in the asthmatic subject, where the noisy "râles" entirely predominate, rendering auscultation of the heart temporarily impracticable.

Obscurities and difficulties arise in a negative way from lack of expression; occasionally, all sounds are distant and confused, responses are slow and ambiguous, and the observer is made to feel the need of a perfected microphone which shall amplify, localize, measure, and, in fine, characterize all obscure indications.

Difficulties from circumstances arise from disturbing voices or footsteps, or the roar and rattle of busy streets, and innumerable other sounds which may in part preoccupy the ear with their clangor. There are difficulties from disinclination on the part of the individual examined to offer the requisite time and facilities. There is too often incompetence on the part of the examiner; his sense of hearing as an auscultator may be defective, though not appreciable by any other test. He may never have acquired the requisite degree of skill gained only by persevering practice, commencing with the normal conditions in healthy persons, thence through every class and grade of morbid states, until he has become the trustworthy adept, if not the technical expert.

Difficulties exist to prevent the full popular benefit from stethoscopy, arising from the want of a better general knowledge of its claims and capabilities. Formerly, when the circulation of the blood and the functions of respiration were unknown and the arteries were supposed to be air-vessels, the *materia medica* was a wonderful list with which the physician made his round of experiments. In those days, in case of a mysterious death, the verdict of the coroner's court would be, "Died by the hand of God," and was considered as duly explicit.

Sufficient advancement has now been made not only to demonstrate the physiology of the lungs, heart, and arteries, but to comprehend every shade of their diseased conditions and to show that the larger part of the remedies once in use were entirely inapplicable; and the coroner, with no irreverent intent, but under the fear of the charge of ignorance, must now demonstrate the physical means and the exact locality of the fatal impress—perhaps found as a heart-obstruction, or a minute embolus deep in the labyrinth of the brain, to which some physiological clew may have led.

Aside from the inherent obscurity and difficulty connected with the subject of medicine, there remains as a heritage of by-gone ages an unwonted mystery associated with it, which should be more rapidly dispelled; and while the profession is making good progress in elaborating and writing its more exact laws, it is the duty of the intelligent laity to free themselves from the vestiges of mysticism, and seize upon the more prominent and available facts and principles which are their appropriate possession.

COAL AND THE COAL-TAR COLORS.

By M. DENYS COCHIN.

WITHIN thirty years, the agriculture of some countries has been subjected to an unprecedented competition. Vegetable productions identical with those they were accustomed to furnish have been extracted from stone-coal. Coal was at first employed only as a combustible; then it gave us gas and illuminating oils. Now it furnishes us perfumes and colors; the flavors of bitter-almonds and of vanilla, and the orange-red of madder, which is no longer cultivated around Avignon. We derive from coal what we used to look for in living plants, and the art of the chemist has fabricated vegetable substances. It would not, however, be correct to say that vegetable substances have been constituted from mineral elements, for coal is not a mineral, but a decomposed vegetable product. It is not pure carbon, but a mixture of hydrocarbons, of combinations which chemistry calls organic, because they proceed from living organisms and preserve a distinctive character peculiar to substances that have been endowed with life. It is not, then, the mineral world that yields us the perfumes and colors that were furnished by plants and flowers, but an intermediate world in which the remains of the vegetation of past ages are preserved.

If we heat bituminous coal in a close vessel communicating with cooled receivers, we shall have carbon left in our retort, mixed with a little sulphuret of iron. This is coke. The products of the distillation that pass over will be of two kinds; a thick liquid, coal-tar, and carbureted hydrogen gases. The gases are used for lighting. Thirty years ago the coal-tar was not used for anything. We shall proceed to inquire what profit is now derived from it. What is it precisely that takes place in the retort? Shall we believe that the light and spongy coke was a kind of skeleton of coal intimately united with more complex substances, and that coal is a mixture of pure carbon and combined carbon? No; coal, as a whole, is a mass of substances composed of combinations of carbon with other bodies. These combinations are modified by heat. The tarry liquids and the gases do not exist in the coal, but are formed as the temperature rises in the retort. Coke is left, because in the changes that are made carbon is in excess. The coal-tar is not separated from the coke, but is made in the retort, and the bodies we find in it are results of combinations that are brought about between the substances which existed in the coal.

M. Berthelot heats to a dull red heat the gas acetylene, the molecule of which is composed of four atoms of carbon and two atoms of hydrogen. At the end of the operation the acetylene is condensed and is changed into a liquid, benzine, which is composed of twelve atoms of carbon and six of hydrogen. Three molecules of acetylene have been in some way welded together to furnish a molecule of benzine. We have seen acetylene condensed and combined as it were with itself. It also combines with hydrogen and forms olefiant gas, or ethylene. The latter unites with the benzine and gives, by synthesis, a liquid hydrocarbon, styrolene, identical with the styrolene which is produced by the styrax or Oriental liquidamber. Finally, from the union of the styrolene and the olefiant gas results naphthaline, a solid hydrocarbon, which crystallizes in thin lamellæ and abounds in coal-tar. Anthracene is one of the most valuable of the hydrocarbon extracts of coal-tar. It evidently did not exist as anthracene in the coal, but has been formed during the distillation, a solid, crystalline body, by the combination and condensation of gases.

So, when coal is heated to a very high temperature, the substances that are disengaged in a gaseous form do not always remain in that state. Heat is not always a cause of the dissolution of bodies and of the dispersion of their elements. When exposed to a temperature exceeding 1,000° C. (1,800° Fahr.) these gases condense; their molecules draw together; and they form, after a few changes, combinations richer in carbon, and consequently less volatile. We had gases, but, when our apparatus has had time to cool, we shall find liquids, even crystals. In other cases, dissociation is effected by heat. Carbonic acid, one of the most common and stable compounds in the world, the final resultant of all combustion, loses its oxygen under excessive heat, and becomes an oxidizing agent. In this way good authorities explain the production of phenic, acetic, and cresylic acids, as hydrocarbons oxidized by the oxygen of carbonic acid. The hydrocarbons may also be dissociated. A liquid hydrocarbon analogous to benzine, toluene, takes hydrogen and leaves a deposit of anthracene. Formene, or marsh-gas, a hydrocarbon which produces chloroform when the hydrogen in it is replaced with chlorine, loses hydrogen and yields anthracene.

Sometimes contrary forces are developed simultaneously, and bodies are at the same time subjected to an influence which brings them together and to another one which separates them ; the result will depend upon slight differences in the temperature or in the proportions of the different bodies present. Benzine and carbonic acid unite to form benzoic acid ; benzoic acid decomposes into carbonic acid and benzine. Styrolene is produced by the union of benzine and olefiant gas, and in decomposing yields benzine and acetylene. Benzine makes its appearance again if anthracene and naphthaline are heated in the presence of hydrogen. Sometimes, between these contrary forces, an equilibrium is established. Thus, acetylene will combine with hydrogen and form olefiant gas ; but olefiant gas will decompose at the same temperature, giving out its two elements ; while, if the three gases are present and all pure, action will be suspended, for the opposing tendencies will be counterbalanced.

These are only a few of the examples of the reactions that take place when organic substances are raised to a high temperature. The four simple substances entering into the constitution of organic bodies form among one another more compounds than are furnished by all the minerals. If heating takes place in the open air, combustion ensues, and all these innumerable substances are oxidized and dissipated in the atmosphere as carbonic acid and aqueous vapor. But, if we work in a medium free from oxygen and all other foreign elements, they react upon one another, and a multitude of bodies are formed or decomposed by the interchange of elements, and the mixture we get when the heat is removed is a mixture of new elements. So, solid and dry coal gives the coal-tar liquids and illuminating gas, which did not exist in it, but were formed under the influence of heat.

Of what organic substances coal is really composed we know only imperfectly. Chemists have not succeeded in making real analyses of it. We can tell how much of impurities, such as sulphuret of iron, it contains, and how much coal-tar and gas can be got from it ; we may classify a specimen as a rich, a poor, or a bituminous coal, or as one giving a long or a short flame, but we do not separate and determine the chemical elements.

The analyst has not very many resources at his disposal for separating an intimate mixture of several bodies. The first means is that of distillation. Different bodies sublime at different temperatures, according to their various degrees of volatility ; each of them, under the same atmospheric pressure, passes from the solid to the liquid state at one temperature, and from the liquid to the gaseous at another. These temperatures are called, respectively, the point of fusion and the boiling-point. Fractional distillations are performed in accordance with this principle. When the heat is raised to a certain degree, one class of bodies, at a higher temperature another class of bodies, which had not reached their boiling-point at the former temperature, will be collected in the cold receiver. The operation becomes complicated and the results perplexing when the mixture consists of substances capable of being modified by the degrees of heat applied. In such cases the analysis must be carried on at a lower temperature, and the operator must depend upon solvents, the effects of which are different on different bodies. This method has been tried on coal by M. Commines de Marcilly, who employed boiling liquids or their vapors in open and in closed vessels, and in Papin's digester, by the aid of which he obtained a stronger pressure than that of the atmosphere. Acids and alkalies had no action, but neutral liquids, such as ether, benzine, sulphuret of carbon, and chloroform, were evidently colored by the coal. The experiments deserve to be carried further.

Coal-tar, the liquid product which is formed when coal is roasted in a close vessel, appears as a thick, black paste, giving no hint of the richness of the substances which may in their turn be formed and separated from it. The first product, water saturated with ammonia, passes over when the liquid is heated to between 175° and 192° Fahr. for twenty or thirty hours. Then a fractional distillation is performed, under which the light oils are separated at below 266° Fahr.; the medium oils at between 266° and 392°; and the heavy oils at between 392° and 678°; while a thick residue is left in the retort. Our study is with the oils.

The first two classes of oils are again distilled in a large alembic heated by steam under high pressure; first is collected for the medium oils all that passes between 266° and 392°. That which passes at below 266° is mixed with light oils, while the products passing at above 392° are mingled with heavy oils. The light oils are next purified in a similar manner. The latter products are known in commerce as naphtha-oils, and are chiefly carburets of hydrogen. The eighteen or twenty of them which have been distinguished form a series, in which the proportion of carbon to hydrogen increases regularly. Those least rich in carbon are gaseous; then come the liquid hydrocarbons, and last the solid compounds. We select the liquid distillates for further operations. The first step is to rid the product of the gases that may still be dissolved in it, and the alkaline or acid impurities it may contain—foreign matters which give to the naphtha a repulsive odor. They are separated by washing successively with water, which removes some of them, sulphuric acid, which acts on the alkalies, and caustic soda for the removal of acids and what excess of sulphuric acid may remain. The naphtha is then subjected to a fourth distillation, and benzine is obtained at a temperature of between 184° and 240°.

Before proceeding with the history of this valuable substance we will mention that the medium oils are treated with sulphuric acid and soda in the same way as the light oils, except that, as they are richer in alkalies and acids, they have to be treated with stronger proportions of the cleansing agents. They are then put into the market as illuminating oils. They may also be used for solutions of India-rubber, but sulphuret of carbon is preferred for that purpose.

Faraday discovered benzine in 1825 among the products arising in the manufacture of oil-gas, and called it bicarbureted hydrogen. Mitscherlich, in 1825, in treating benzoic acid with soda, obtained a volatile liquid which he called benzine. Hofmann, in 1825, demonstrated that these two substances were the same. Berthelot explained the formation of the substance, and made a synthesis of it by heating acetylene, its molecule being composed of three molecules of that gas united, or of twelve atoms of carbon and six of hydrogen. Benzine is a type of a class of organic bodies that furnish, by substitution, innumerable series of derivatives. They are like buildings from which we can take the stones one at a time and replace them with others. They are the organic radicals, in which a number of atoms of carbon and hydrogen are associated in such a way that the energy of one atom of hydrogen is left free. In benzine, for instance, we may substitute for each atom of hydrogen an atom of chlorine and get benzine monochloride, benzine dichloride, etc., or an atom of bromine or iodine and get benzine bromide and benzine iodide; or another radical, such as methyl or ethyl, and get methylbenzine or ethylbenzine, dimethylbenzine, trimethylbenzine, and so on. These theories permit us to account for the long series of bodies which organic chemistry has revealed, many of which are now employed in industry.

Benzine, as everybody knows, is a light liquid, perfectly colorless, and having a nauseous odor. It nevertheless furnishes perfumes and dyes. Charles Mansfield, who was the first person to utilize benzine, and make it on a large scale, announced in 1847 that he had found among the derivatives of stone-coal an oil that might take the place of the oil of bitter-almonds. It was nitrobenzine. Mitscherlich had previously produced, by the lively reaction of nitric acid on benzine, a colorless liquid, in which a compound molecule of nitrogen and oxygen was substituted for one of the six atoms of hydrogen in benzine, but his experiment never got beyond the laboratories. It was attended by too great dangers. Nevertheless, Mansfield ventured to repeat it in his shop, and succeeded in basing an industrial operation upon it. Nitrobenzine can not be pure unless the benzine was pure, and that is rarely the case with the commercial article. In the mixture of hydrocarbons, of which naphtha is constituted, are some very nearly alike in composition and in respect to their boiling-point, and it is difficult, even with the best distilling apparatus, to arrest the passage of some of them. Toluene, for example, nearly always comes over with benzine. Like it, it is attacked by nitric acid and then yields a nitrotoluene. There has also been found, associated with nitrobenzine, a peculiar yellowish-colored acid, endowed with the smell and taste of the pineapple; and its ethers taste like the strawberry or the raspberry. It has given the flavor to many a sherbet and many a confection.

Nitrobenzine is known in trade under the purely fanciful name of essence of mirbane, and is used by perfumers as a substitute for the oil of bitter-almonds—a substance which is also made artificially. It plays an important part in modern industry, because it is employed in the manufacture of aniline.

As the experiments in synthesis are continued, and more and more complicated bodies are evolved from the primitive hydrocarbon, the wealth of the field of researches open to the investigator becomes more and more surprising. How many combinations have already been effected, and how many thousand remain to be discovered! Benzine is only one of many hydrocarbons derived from coal-tar, and nitrobenzine is only one of the nitrogenized derivatives from it. There are also iodine, bromine, and chlorine derivatives, which may be obtained, not only by successive substitutions of those substances for one or more atoms of hydrogen, but also by additions of them, without displacing hydrogen. Sulpho-derivatives are also known, as well as nitrogenized derivatives of benzine chloride, iodide, and bromide. Instead of chlorine, iodine, and bromine, we may substitute organic radicals for hydrogen and get other new series. And these series of derivatives furnished by benzine are paralleled by other like series derived from toluene, xylene, and a hundred other hydrocarbons. Mathematicians exhibit a formidable total of the different possible arrangements according to which the units may be grouped by twos and threes, etc.; the seven notes of the musical scale are arranged in infinite variations; and chemistry disposes the seven or eight bodies occurring in organic matters in a similar endless diversity of combinations. If we are permitted to extend the comparison, we may say that as the musical arrangements are based upon a certain fundamental chord, so types of chemical arrangements center around a particular model, like benzine, to which it is easy to bring the whole series into relation.

Aniline exists already formed in coal-tar, but in very small quantity. Industry does not look after it, for the processes of extraction would be too costly. It is more convenient to make nitrobenzine and then reduce it, or deprive it of its oxygen by bringing it in contact with substances that will take that element from it. This may be effected by several processes. Sulphureted hydrogen, iron in fine particles, and acetic acid, are often employed as reducing agents. All the substances we have thus far derived from coal-tar are colorless. The moment has come for colors to appear. We have obtained aniline by deoxidizing nitrobenzine. If we are expecting in turn to recover nitrobenzine by oxidizing aniline, we shall find ourselves mistaken. We can, indeed, fix oxygen upon the hydrogen, but the hydrogen-atoms will separate during the process from the molecule of aniline.

Not a fixation of oxygen, but a departure of hydrogen, takes place. Then a phenomenon of condensation is exhibited ; a number of the molecules unite to form a molecule of rosaniline. This wonderful colorant may be constituted by the action of almost any of the oxidizing agents known in chemistry upon aniline. Curiously, rosaniline would not be formed if the aniline were absolutely pure. Theoretically, its molecule is formed by the union of a molecule of aniline and two molecules of toluidine, with a loss between the two of six atoms of hydrogen. It can not be obtained by oxidizing either of these bases separately. Rosaniline is solid at ordinary temperatures, and crystallizes readily in lozenges or in fine needles, which are white when protected from the air, but become rose and then red when brought in contact with it. The nature of the change it undergoes is unknown. It is not apparent in the composition. Rosaniline is soluble in water, and more soluble in alcohol, and has basic qualities so strong as to displace ammonia from its salts ; and it is most frequently employed as a salt. It furnishes not red only, but all colors, according as it is treated in the combinations into which it is made to enter. Violet was first discovered by Mr. Perkins, in 1856, while trying to make artificial quinine by the action of bichromate of potash on sulphate of aniline. He gave up the search for quinine, and turned his attention to manufacturing the color. Three years afterward MM. Renard and Verguin produced fuchsine, a purple salt of rosaniline, by treating commercial aniline with a dehydrogenizing agent, bichloride of tin. It is a mixture of hydrochlorate of rosaniline and salts of tin, and is used by dyers and wine-merchants. Aniline is now oxidized by the action of arsenic into *crude red* (*rouge brut*), a violet mixture, composed principally of arsenite and arseniate of rosaniline, which is converted into fuchsine by bringing about a substitution of hydrochloric for arsenious or arsenic acid. This is done by boiling crude red with hydrochloric acid, or, more usually, with sea-salt. A double decomposition takes place, and, when the liquor is cooled, crystals of fuchsine are found in the bottom of the vessel, while the arsenites and arseniates of soda are retained in the mother-water. Not all the coloring-matter, however, is deposited in the crystals, and a good operator loses nothing. Treated with carbonate of soda, the mother-water gives a precipitate, from which is extracted a color known as aniline garnet or yellow fuchsine. Nor is this all. The crude red has left a violet deposit in the bottom of the boats in which it was cooled ; this is washed in boiling water ; the water is colored red, and a blue dye-stuff is collected from it. More is left still. The crude red has passed through filters, and they have retained some insoluble substances. These are carefully gathered up ; they form a paste which is boiled with diluted hydrochloric acid and filtered over again to extract what fuchsine is left. The insoluble residue furnishes aniline maroon, a beautiful color readily applicable to wool. Thus a single operation has given us the violet red of fuchsine, garnet, blue, and maroon.

Whence come all of these colors? And how does chemistry explain the provision of so various hues by the same body? The differences do not arise solely from the fact that the same base, rosaniline, is found associated with different acids. We must not forget that we had at first, notwithstanding the separations effected by fractional distillations, a mixture of substances. These substances react upon one another; and the theory of their reactions, of which we have already given some idea, appears so ingenious and interesting that we must say a few words more about it.

Benzine and toluene, mixed, furnished, after some reactions, a mixture of aniline and toluidine. Two molecules of toluidine and one molecule of aniline united, with a loss of hydrogen, to form a molecule of rosaniline. Now, two molecules of aniline and one molecule of toluidine, also losing hydrogen, might also unite in a similar manner; or three molecules of aniline, or three molecules of toluidine, might be introduced in the process, with analogous results. Here we have four distinct arrangements, four possible cases, conceived in theory and realized in practice. In the first case we had rosaniline; in the second, we have mauvaniline; in the third, violaniline; and, in the fourth, chrysotoluidine. We have described the first of these substances. The second forms light-brown crystals, that become darker on heating, while the liquids in which they are dissolved take a violet tinge. Violaniline is hardly soluble, and difficult to get crystallized; it is a very dark—nearly black—brown powder. Its salts, when a few drops of concentrated sulphuric acid are added to the solution, give a dark blue. Chrysotoluidine is yellow. All these bodies are formed during the preparation of fuchsine, and are separated by filtration or through their differences in solubility, or incapacity for crystallization. The separation of the substances which do not crystallize is difficult and incomplete. The red continues united with the yellow in greater or less proportion, and gives maroon or garnet.

Through all these processes, in which we have observed the hydrocarbons decomposing one another, and forming new compounds, we have found that the chemistry of coal does not always have to borrow its powerful reagents, its acids and alkalies, from mineral chemistry; but that the compounds of carbon themselves, closely allied in constitution and properties, are very frequently capable of reacting upon and transforming one another, without the intervention of foreign agents. Instead of acids uniting with bases to give rise to a third kind of bodies, salts, we have carburets, bases, uniting by twos or by threes, with or without the loss of one of their elements, and forming double or triple molecules of compounds, which may still be of the same chemical type. The first experiments in the practical application of these reactions were made by MM. Charles Girard and De Laire. Chemists, as we have said, understand by organic radicals certain groups of atoms of carbon and hydrogen, which are capable of combining with an atom of hydrogen in the same manner as an atom of bromine, or iodine, or chlorine, or which may be substituted for an atom of one of these substances in one of its combinations. In a complex body like rosaniline, one or more atoms of hydrogen may be removed and replaced by as many atoms of the organic radical. MM. Girard and De Laire caused aniline to react upon rosaniline. Aniline is an organic base, an ammoniacal compound. In common ammonia, one atom of nitrogen is combined with three atoms of hydrogen. In aniline, one of the atoms of hydrogen is replaced by the radical phenyle. The converse is also possible, and, if phenyle is in its turn replaced by hydrogen, the ammonia should reappear. This reaction was provoked by heating fuchsine and aniline together. Rosaniline gave up an atom of hydrogen and took the radical phenyle. Aniline lost phenyle, which was replaced by hydrogen ; the ammonia was disengaged, and phenyl-rosaniline was produced. It is a bright sky-blue. We can vary its color. The exchange we have just described may be effected successively for three atoms of hydrogen against three molecules of phenyle, according to the amount of aniline employed ; and we shall have monophenyle, diphenyle, or triphenyle rosaniline. The first is violet-blue, the second clear-blue, and the third a blue we might call blue-light (*bleu lumière*), because its hue loses none of its freshness—and, in fact, gains luster—even in an artificial light.

MM. Girard and Laire's discovery was of great theoretical and practical interest, and important consequences followed it. The method was general, and permitted the substitution, in most of the organic bases, of radicals for two or three atoms of hydrogen. The same chemists succeeded in doing with the hydrochlorate of aniline as they had done with the hydrochlorate of rosaniline, and obtained diphenylated and triphenylated aniline, from which they extracted blue coloring matters ; then they brought the salts of these complex bases under the review of their experiments. An iodine salt of trimethylated rosaniline gave them a magnificent green, of such fixity and luster that it might be called, like the blue which they had previously prepared, green-light (*vert lumière*).

The light oils of coal-tar are almost wholly composed of carburets of hydrogen ; in the heavy oils bases and acids are also found with some very condensed carburets. They contain, for example, the ready-formed aniline, which it has not been found profitable to extract from them, and phenic acid, which, besides its valuable antiseptic properties, has been serviceable to the fabricants of coloring matters. In 1834 M. Runge, in preparing phenic acid, found in the residue a yellow substance, which is called coralline, or rosolic acid. In 1859 M. Jules Persoz, heating this substance with ammonia, obtained a beautiful red body, which he called peonine. Two years afterward, the manufacturers to whom he sold his patents put in the market a sky-blue substance, azuline, which also was a derivative of rosolic acid. The precise nature of rosolic acid has not been determined ; but M. Fresenius has extracted an orange-yellow matter from it, which he calls aurine, and has devised a process for procuring it by heating phenic and sulphuric acids together, and adding oxalic acid six or seven hours afterward. It is not much used now, but is of interest as furnishing in itself blue, red, and yellow. The most important bodies derived from the heavy oils are naphthaline and anthracene, both carburets of hydrogen. Naphthaline, which is solid at ordinary temperatures, and crystallizes with great facility in thin lamellæ, is obtained simply by leaving the oils in the cold for five or six days, when it becomes solidified. The liquid is decanted off, and the crystals are pressed, to remove the included oil, into thick cakes. Naphthaline is a member of the same series as benzine, and is subject to a similar series of reactions. Reducing its nitrate, Zinin obtained an organic base analogous to aniline, naphthylamine, which is transformed by the loss of hydrogen into rosanaphthylamine. From this is obtained the hydrochlorate of rosanaphthylamine, a body analogous with fuchsine, of a beautiful rose-color, and easily crystallizable, but of a clearer rose with less of violet than fuchsine. It is dull when applied to wool, but gives very brilliant hues with silk. Dissolved in alcohol, it produces a strange and wonderful effect. The liquid turns bright red, and, under proper presentation to the light, may be seen to be traversed with phosphorescent clouds. If left to stand till the alcohol has slowly evaporated, the bottom of the vessel will be covered with beautiful green, iridescent needles. Naphthaline also furnishes some very complex compounds, whence have been derived very yellow dyes, among which Manchester yellow and Martins yellow are the best known. Experiments in substituting molecules of organic radicals for atoms of hydrogen, as has been done with rosaniline, have been made with some success, but the blues thus obtained have not the remarkable fixity and luster of the similar rosaniline products.

No discovery of coal-tar products is more extraordinary or more fruitful in its bearings than that of the extraction of alizarine, or the artificial preparation of the coloring principle of madder, the effect of which has been to work a real economical revolution, and to destroy the most profitable agricultural industry of large districts of country. The madder-root has furnished the most generally used of all dye-stuffs, and the one which constituted the basis of nearly all our colors. The substance to which it owes its peculiar virtues still performs the same functions, but, instead of being derived from the cultivated root, it is now procured by chemical synthesis from stone-coal.

Alizarine is prepared from anthracene, the second of the more important bodies which we have already spoken of as contained in the heavy oils of coal-tar. It forms a part of the deposit of solids which forms when the heavy oils are left standing in the cold, from which are obtained the crystals of naphthaline. When this deposit is raised to a temperature of 250° C. (482° Fahr.), the naphthaline and the indefinite oily substances are distilled away, and there is left anthracene, with some impurities. The impurities may be removed by means of the very light oils of petroleum, which dissolve them and leave the anthracene; or by the light oils of coal-tar, which dissolve the anthracene and leave them. When anthracene has been sufficiently purified it is submitted to the action of oxidizing agents, and anthraquinone is obtained by precipitation as a resultant. By this direct process we have made a ternary body of our hydrocarbon, and have combined it with a proportion of oxygen which we can not increase by any further process of a direct character; but the alizarine which we are seeking to get is richer in oxygen than anthraquinone. The second degree of oxidation has to be attained by an indirect process; we bring it about by withdrawing some atoms of hydrogen from the molecule and substituting for them molecules containing oxygen. The authors of the synthesis accomplished it in a process of two steps, by putting bromine in place of hydrogen and the elements of water in place of the bromine. But bromine is expensive, and so the manufacturers now make alizarine, not from a bromized but from a sulphureted anthraquinone. Of all the coloring substances derived from coal-tar, alizarine is the one which is now made in the greatest quantity. According to the report of M. Würtz, made in 1878, eight factories, two of which were very extensive, were then in full activity in Germany, two in Switzerland, one in England, and one in France, which last the proprietors had had the courage to establish in the very center of the madder-raising district. The quantity of alizarine then produced was estimated at 3,500 kilogrammes, or nearly 9,000 pounds daily, and it has doubtless been since considerably increased.

Anthracene, the basis of the manufacture of alizarine, is relatively abundant in coal-tar, forming sometimes from seven to eight per cent of its mass. It has been observed that coal-tar is rich in anthracene in proportion as it is poor in toluene, and M. Berthelot has explained the fact by showing that toluene, decomposed by heat, produces anthracene; hence the relative amount obtained of either is likely to vary according to the temperature-conditions of the distillation. The differences may also probably depend upon the character of the coal and of the matter first employed at the point of departure of all the operations. But, as we have said, this point of departure is essentially unknown. All of our products have been obtained from a vegetable or organic, not from the primary mineral, carbon; not from carbon either, but from compounds of carbon and hydrogen of a character which we have not yet been able to produce by synthesis of the primary mineral elements, but which the sun stored up for us ages ago, working through the agency of organic growth. From a black and amorphous matter we have made to issue crystalline substances of every shade of color—reds, saffrons, greens, violets, and blues—alizarine, the same substance as tints the flowers of the madder, and that wonderful aniline, colorless as the ray of light before it has been resolved by the prism, but containing *in posse*, like the same ray, all the colors of the rainbow. What do we know of stone-coal, the origin of so many marvels and refractory to all analysis? Nothing, except that it has lived.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXX.

THE changes which occur when starch-granules are subjected to the action of water, at a temperature of 140°, have been described. If the heat is raised to the boiling-point, and the boiling continues, the gelatinous mass becomes thicker and thicker; and if there are more than fifty parts of water to one of starch a separation takes place, the starch settling down with its fifty parts of water, the excess of water standing above it. Carefully-dried starch may be heated to above 300° without becoming soluble, but at 400° a remarkable change commences. The same occurs to ordinary commercial starch at 320°, the difference evidently depending on the water retained by it. If the heat is continued a little beyond this it is converted into *dextrin*, otherwise named "British gum," "gommeline," "starch-gum," and "Alsace gum," from its resemblance to gum-arabic, for which it is now very extensively substituted. Solutions of this in bottles are sold in the stationers' shops under various names for desk uses.

The remarkable feature of this conversion of starch into dextrin is that it is accompanied by no change of chemical composition. Starch is composed of six equivalents of carbon, ten of hydrogen, and five of oxygen—$C_6H_{10}O_5$, i. e., six of carbon and five of water or its elements. Dextrin has exactly the same composition; so also has gum-arabic when purified. But their properties differ considerably. Starch, as everybody knows, when dried, is white, and opaque and pulverent; dextrin, similarly dried, is transparent and brittle; gum-arabic the same. If a piece of starch, or a solution of starch, is touched by a solution of iodine, it becomes blue almost to blackness, if the solution is strong; no such change occurs when the iodine solution is added to dextrin or gum. A solution of dextrin when mixed with potash changes to a rich blue color when a little sulphate of copper is added; no such effect is produced by gum-arabic, and thus we have an easy test for distinguishing between true and fictitious gum-arabic.

The technical name for describing this persistence of composition with changes of properties is *isomerism*, and bodies thus related are said to be *isomeric* with each other. Another distinguishing characteristic of dextrin is that it produces a right-handed rotation on a ray of polarized light—hence its name, from *dexter*, the right.

The conversion of starch into dextrin is a very important element of the subject of vegetable cooking, inasmuch as starch-food can not be assimilated until this conversion has taken place, either before or after we eat it. I will therefore describe other methods by which this change may be effected.

If starch be boiled in a dilute solution of almost any acid, it is converted into dextrin. A solution containing less than one per cent of sulphuric or nitric acid is sufficiently strong for this purpose. One method of commercial manufacture (Payen's) is to moisten ten parts of starch with three of water, containing $\frac{1}{150}$ of its weight of nitric acid, spreading the paste upon shelves, allowing it to dry in the air, and then heating it for an hour and a half at about 240° Fahr.

But the most remarkable and interesting agent in effecting this conversion is *diastase*. It is one of those mysterious compounds which have received the general name of "ferments." They are disturbers of chemical peace, molecular agitators that initiate chemical revolutions, which may be beneficent or very mischievous. The morbific matter of contagious diseases, the venom of snake-bite, and a multitude of other poisons, are ferments. Yeast is a familiar example of a ferment, and one that is the best understood. I must not be tempted into a dissertation on this subject, but may merely remark that modern research indicates that many of these ferments are microscopic creatures, linking the vegetable with the animal world; they may be described as living things, seeing that they grow from germs and generate other germs that produce their like. Where this is proved, we can understand how a minute germ may, by falling upon suitable nourishment, increase and multiply, and thus effect upon large quantities of matter the chemical revolution above named.

I have already described the action of rennet upon milk, and the very small quantity which produces coagulation. There appears to be no intercession of living microbia in this case, nor have any been yet demonstrated to constitute the ferment of diastase, though they may be suspected. Be this as it may, diastase is a most beneficent ferment. It communicates to the infant plant its first breath of active life, and operates in the very first stage of animal digestion.

In a grain of wheat, for example, the embryo is surrounded with its first food. While the seed remains dry above-ground there is no assimilation of the insoluble starch or gluten, no growth, nor other sign of life. But when the seed is moistened and warmed, the starch is changed to dextrin by the action of diastase, and the dextrin is further converted into sugar. The food of the germ thus gradually rendered soluble penetrates its tissues; it is thereby fed and grows, unfolds its first leaf upward, throws downward its first rootlet, still feeding on the converted starch until it has developed the organs by which it can feed on the carbonic acid of the air and the soluble minerals of the soil. But for the original insolubility of the starch it would be washed away into the soil, and wasted ere the germ could absorb it. The maltster, by artificial heat and moisture, hastens this formation of dextrin and sugar; then by a roasting heat kills the baby plant just as it is breaking through the seed-sheath. Blue-ribbon orators miss a point in failing to notice this. It would be quite in their line to denounce with scathing eloquence such heartless infanticide.

Diastase may be obtained by simply grinding freshly germinated barley or malt, moistening it with half its weight of warm water, allowing it to stand, and then pressing out the liquid. One part of diastase is sufficient to convert two thousand parts of starch into dextrin, and from dextrin to sugar, if the action is continued. The most favorable temperature for this is from 140° to 150° Fahr. The action ceases if the temperature be raised to the boiling-point.

The starch which we take so abundantly as food appears to have no more food-value to us than to the vegetable germ until the conversion into dextrin or sugar is effected. From what I have already stated concerning the action of heat upon starch, it is evident that this conversion is more or less effected in some processes of cookery. In the baking of bread an incipient conversion probably occurs throughout the loaf, while in the crust it is carried so far as to completely change most of the starch into dextrin, and some into sugar. Those of us who can remember our bread-and-milk may not have forgotten the gummy character of the crust when soaked. This may be felt by simply moistening a piece of crust in hot water and rubbing it between the fingers. A certain degree of sweetness may also be detected, though disguised by the bitterness of the caramel, which is also there.

The final conversion of starch-food into dextrin and sugar is effected in the course of digestion, especially, as already stated, in the first stage—that of insalivation. Saliva contains a kind of diastase, which has received the name of *salivary diastase* and *mucin*. It does not appear to be exactly the same substance as vegetable diastase, though its action is similar. It is most abundantly secreted by herbivorous animals, especially by ruminating animals. Its comparative deficiency in carnivorous animals is shown by the fact that, if vegetable matter is mixed with their food, starch passes through them unaltered.

Some time is required for the conversion of the starch by this animal diastase, and in some animals there is a special laboratory or kitchen for effecting this preliminary cookery of vegetable food. Ruminating animals have a special stomach-cavity for this purpose in which the food, after mastication, is held for some time and kept warm before passing into the cavity which secretes the gastric juice. The crop of grain-eating birds appears to perform a similar function. It is there mixed with a secretion corresponding to saliva, and is thus partially malted—in this case *before* mastication in the gizzard.

At a later stage of digestion, the starch that has escaped conversion by the saliva is again subjected to the action of animal diastase contained in the pancreatic juice, which is very similar to saliva.

It is a fair inference from these facts that creatures like ourselves, who are not provided with a crop or compound stomach, and manifestly secrete less saliva than horses or other grain-munching animals, require some preliminary assistance when we adopt graminivorous habits; and one part of the business of cookery is to supply such preliminary treatment to the oats, barley, wheat, maize, peas, beans, etc., which we cultivate and use for food.

XXXI.

Having described the changes effected by heat upon starch, and referred to its further conversion into dextrin and sugar, I will now take some practical examples of the cookery of starch-foods, beginning with those which are composed of pure, or nearly pure, starch.

When arrowroot is merely stirred in cold water it sinks to the bottom undissolved and unaltered. When cooked in the usual manner to form the well-known mucilaginous or jelly-like food, the change is a simple case of the swelling and breaking up of the granules described as occurring in water at the temperature of 140° Fahr. There appears to be no reason for limiting the temperature, as the same action takes place from 140° upward, to the boiling-point of water.

I may here mention a peculiarity of another form of nearly pure starch-food, viz., tapioca, which is obtained by pulping and washing out the starch-granules of the root of the *manihot*, then heating the washed starch in pans and stirring it while hot with iron or wooden paddles. This cooks and breaks up the granules and agglutinates the starch into nodules which, as Mr. James Collins explains ("Journal of Society of Arts," March 14, 1884), are thereby coated with dextrin, to which gummy coating some of the peculiarities of tapioca-pudding are attributable. It is a curious fact that this manihot-root, from which our harmless tapioca is obtained, is terribly poisonous. The plant is one of the large family of nauseous spurgeworts (*Euphorbiaceæ*). The poison resides in the milky juice surrounding the starch-granules, but, being both soluble in water and volatile, most of it is washed away in separating the starch-granules, and any that remains after washing is driven off by the heating and stirring which has to reach 240°, in order to effect the changes above described.

I suspect that the difference between the forms of tapioca and arrowroot has arisen from the necessity of thus driving off the last traces of the poison with which the aboriginal manufacturers were so well acquainted as to combine the industry of poisoning their arrows with that of extracting the starch-food from the same root. No certificate from the public analyst is demanded to establish the absence of the poison from any given sample of tapioca, as the juice of the manihot-root, like that of other spurges, is unmistakably acrid and nauseous.

Sago, which is a starch obtained from the pith of the stem of the sago-palm and other plants, is prepared in grains like tapioca, with similar results. Both sago and tapioca contain a little gluten, and therefore have more food-value than arrowroot.

The most familiar of our starch-foods is the potato. I place it among the starch-foods, as, next to water, starch is its prevailing constituent, as the following statement of average compositions will show: Water, 75 per cent; starch, 18·8; nitrogenous materials, 2; sugar, 3; fat, 0·2; salts, 1. The salts vary considerably with the kind and age of the potato, from 0·8 to 1·3 in full grown. Young potatoes contain more. In boiling potatoes, the change effected appears to be simply a breaking up or bursting of the starch-granules, and a conversion of the nitrogenous gluten into a more soluble form, probably by a certain degree of hydration. As we all know, there are great differences among potatoes, some are waxy, others floury; and these, again, vary according to the manner and degree of cooking. I can not find any published account of the chemistry of these differences, and must, therefore, endeavor to explain them in my own way.

As an experiment, take two potatoes of the floury kind; boil or steam them together until they are just softened throughout, or, as we say, "well done." Now leave one of them in the saucepan or steamer, and very much overcook it. Its floury character will have disappeared, it will have become soft and gummy. The reader can explain this by simply remembering what has already been explained concerning the formation of dextrin. It is due to the conversion of some of the starch into dextrin. My explanation of the difference between the waxy and floury potato is that the latter is so constituted that all the starch-granules may be disintegrated by heat in the manner already described, before any considerable proportion of the starch is converted into dextrin, while the starch of the waxy potatoes for some reason, probably a larger supply of diastase, is so much more readily convertible into dextrin that a considerable proportion becomes gummy before the whole of the granules are broken up—i. e., before the potato is cooked or softened throughout.

I must here throw myself into the great controversy of jackets or no jackets. Should potatoes be peeled before cooking, or should they be boiled in their jackets? I say most decidedly in jackets, and will state my reasons. From 53 to 56 per cent of the above-stated saline constituents of the potato is potash, and potash is an important constituent of blood—so important that in Norway, where scurvy once prevailed very seriously, it has been banished since the introduction of the potato, and, according to Lang and other good authorities, it is owing to the use of this vegetable by a people who formerly were insufficiently supplied with saline vegetable food.

Potash salts are freely soluble in water, and I find that the water in which potatoes have been boiled contains potash, as may be proved by boiling it down to concentrate, then filtering and adding the usual potash test, platinum chloride.

It is evident that the skin of the potato must resist this passage of the potash into the water, though it may not fully prevent it. The bursting of the skin only occurs at quite the latter stage of the cookery. The greatest practical authorities on the potato, Irishmen, appear to be unanimous. I do not remember to have seen a pre-peeled potato in Ireland. I find that I can at once detect by the difference of flavor whether a potato has been boiled with or without its jacket, and this difference is evidently saline.

These considerations lead to another conclusion, viz., that baked potatoes, and fried potatoes, or potatoes cooked in such a manner so as to be eaten with their own broth, as in Irish stew (in which cases the previous peeling does no mischief), are preferable to boiled potatoes. Steamed potatoes probably lose less of their potash juices than when boiled; but this is uncertain, as the modicum of distilled water condensed upon the potato and continually renewed may wash away as much as the larger quantity of hard water in which the boiled potato is immersed.

Those who eat an abundance of fruit, of raw salads, and other vegetables supplying a sufficiency of potash to the blood, may peel and boil their potatoes; but the poor Irish peasant who depends upon the potato for all his sustenance requires that they shall supply him with potash.

When traveling in Ireland (I explored that country rather exhaustively when editing the fourth edition of "Murray's Hand-book"), I was surprised at the absence of fruit-trees in the small farms where one might expect them to abound. On speaking of this, the reason given was that all trees are the landlord's property; that if a tenant should plant them they would suggest luxury and prosperity, and therefore a rise of rent; or, otherwise stated, the tenant would be fined for thus improving the value of his holding. This was before the passing of the Land Act, which we may hope will put an end to such legalized brigandage. With the abolition of rack-renting, the Irish peasant may grow and eat fruit; may even taste jam without fear and trembling; may grow rhubarb and make pies and puddings in defiance of the agent. When this is the case, his craving for potato-potash will probably diminish, and his children may actually feed on bread.

As regards the nutritive value of the potato, it is well to understand that the common notion concerning its cheapness as an article of food is a fallacy. Taking Dr. Edward Smith's figures, 760 grains of carbon and 24 grains of nitrogen are contained in one pound of potatoes; two and one half pounds of potatoes are required to supply the amount of carbon contained in one pound of bread; and three and one half pounds of potatoes are necessary for supplying the nitrogen of one pound of bread. With bread at three halfpence per pound, potatoes should cost less than one halfpenny per pound, in order to be as cheap as bread for the hard-working man who requires an abundance of nitrogenous food.

My own observations in Ireland have fully convinced me of the wisdom of William Cobbett's denunciation of the potato as a staple article of food. The bulk that has to be eaten, and is eaten, in order to sustain life, converts the potato-feeder into a mere assimilating machine during a large part of the day, and renders him unfit for any kind of vigorous mental or bodily exertion. If I were the autocratic Czar of Ireland, my first step toward the regeneration of the Irish people would be the introduction, acclimatizing, and dissemination of the Colorado beetle, in order to produce a complete and permanent potato-famine. The effect of potato-feeding may be studied by watching the work of a potato-fed Irish mower or reaper who comes across to work upon an English farm where the harvest-men are fed in the farm-house and where beer is not excessive. The improvement of his working powers after two or three weeks of English feeding is comparable to that of a horse when fed upon corn, beans, and hay, after feeding for a year on grass only.

The reader may have observed that the starch-foods already described are all derived from the roots or stems of plants. Many others might be named that are used in tropical climates where little labor is demanded or done, and but little nitrogenous food required. Having treated the cookery of the chief constituents of these parts of the plant, the fiber and the starch, I now come to food obtained from the seeds and the leaves.

Taking the seeds first, as the more important, it becomes necessary to describe the nitrogenous constituents which are more abundant in them than in any other part of the plant, though they also contain the starch and cell material, or woody fiber, as already stated.

In No. 29 of this series, page 65, I described a method of separating starch from flour by washing a piece of dough in water, and thereby removing the starch-granules, which fall to the bottom of the water. If this washing is continued until no further milkiness of the water is produced, the piece of dough will be much reduced in dimensions, and changed into a gray, tough, elastic, and viscous or glutinous substance, which has been compared to bird-lime, and has received the appropriate name of *gluten*. When dried, it becomes a hard, horny, transparent mass. It is insoluble in cold water, and partly soluble in hot water. It is soluble in strong vinegar, and in weak solutions of potash or soda. If the alkaline solution is neutralized by an acid, the gluten is precipitated.

If crude gluten obtained as above is subjected to the action of hot alcohol it is separated into two distinct substances, one soluble and the other insoluble. As the solution cools, a further separation takes place of a substance soluble in hot alcohol, but not in cold, and another soluble in either hot or cold alcohol. The first—viz., that insoluble in either hot or cold alcohol—has been named *gluten-fibrin;* that soluble in hot alcohol, but not in cold, *gluten-casein;* and that soluble in either hot or cold alcohol, *gluten*. I give these names and explain them, as my readers may be otherwise puzzled by meeting them in books where they are used without explanation, especially as there is another substance, presently to be described, to which the name of vegetable casein has also been applied. The gluten-fibrin is supposed to correspond with blood-fibrin, gluten-casein with animal casein, and gluten with albumen.—*Knowledge.*

ENSILAGE AND FERMENTATION.

By MANLY MILES, M. D.

THE preservation of green fodder in the form of ensilage is now attracting so large a share of the attention of practical farmers, that a brief sketch of the history of the process, and an outline of the known facts in regard to fermentation, must be of interest to the general reader, as well as the student who wishes to trace the laws of evolution in the development of improved methods in agriculture.

Nearly thirty years ago, Adolf Reihlen, who owned a sugar-factory near Stuttgart, in Germany, preserved a crop of fodder-corn, which had been injured by frost, by burying it in trenches or pits, and covering it with the soil thrown out to protect it from the atmosphere. This method of preserving corn-fodder was suggested by the well-known process of making "brown or sour hay" by packing newly-cut grass in pits, which had been practiced for many years by farmers in Europe.

When the pits were opened, several months afterward, the fodder-corn had a greenish color and a peculiar odor, but its value as cattle-food was not apparently diminished. M. Reihlen was so well pleased with the results of his experiment, that he made a practice of "pitting" a quantity of fodder-corn every year, to obtain a supply of succulent feed for his cattle during the winter.

In 1870 M. Vilmorn called the attention of French farmers to the advantages of this method of preserving green fodder, which M. Reihlen had then successfully practiced for many years. The new method was so favorably received and extensively introduced in France, that it soon became known as the French system of ensilage. The application to a new crop of the old system of curing grass as "brown or sour hay" was in fact accepted as a practically new method, which was designated as the "ensilage of maize."

M. Morel seems to have been the pioneer in the practice of the new system, the results of his experience having been published in the "Journal d'Agriculture pratique" of October 19, 1871. Others, encouraged by this report, followed his example, and for several years the "ensilage of maize" was the leading topic of discussion in the agricultural papers of France. In 1877 M. Auguste Goffart published, in Paris, a work on ensilage, giving his experience for several years with silos of masonry above ground, in which the covers of boards were loaded to give a continuous pressure to the mass, and thus exclude the air. The covering and weighting of the silo, as practiced by M. Goffart, was an improvement on former methods, and it appears to be the only point on which he can make a claim of originality. A translation of this work, which has been the standard authority on ensilage, was published in New York in 1878, and had a marked influence on the introduction of the system in this country.

As early as 1873 agricultural papers in Great Britain and America gave occasional brief notices of the preservation of green fodder in pits as practiced in France and Germany, and the process was usually referred to as the "potting" or "pitting" of fodder.

In 1875 three earth-silos were filled with fodder-corn and broom-corn seed, under my direction, in Illinois, with results that were quite satisfactory. These experiments were reported in "The Country Gentleman" in 1876, page 627, together with an account of the experience of several French farmers who had used ensilage on a large scale. In this paper the French terms "silo" and "ensilage" were introduced, as they had a definite meaning not well expressed by any English words, and they are now in common use.

Mr. Francis Morris, of Maryland, who has had the credit of making the first experiments with ensilage in this country, made his first silo in 1876. Others soon followed his example, and now we find silos in every part of the country, and ensilage has become a familiar cattle-food. The first silos, as we have seen, were simple pits dug in the ground, and the soil thrown out was used to cover and protect the ensilage. In many soils these pits served but a temporary purpose; and the next step in their development was a lining of masonry to give the pits a permanent character. From the difficulty of keeping the water out of these pits, in many localities, silos of masonry were made above ground, and these at first were massive and expensive.

The next step in advance, which quite naturally followed, was, to substitute a movable cover of boards, with weights to give the required pressure, for the cover of earth which had been used in the less perfect form of the silo. As an air-tight inclosure was found to be the essential condition in the construction of a silo, lighter walls were made as a matter of economy, with good results, and even frames of timber, lined with boards or planks, were substituted for the more expensive structures, with complete success.

A balloon-frame of scantling, of suitable size, covered on the outside with matched boards, and lined on the inside with two thicknesses of one-inch matched boards, with a layer of tarred paper between them, thus securing a practically air-tight inclosure surrounded by a dead-air space as a protection against frost, is, in the opinion of the writer, the best and cheapest form of construction. If the boards and timbers are saturated with hot coal-tar, which can readily be done with trifling expense, the durability of the silo will be very much increased. From the fact that wood is not so good a conductor of heat as walls of masonry, it will be seen, from what follows, that wooden silos may have an important advantage over any others in preserving the ensilage, which, in connection with the saving of expense in their construction, must have an influence in bringing them into general use.

There are many conflicting statements in regard to the value of ensilage as a cattle-food, and it may be that the failure to realize the exaggerated claims that were made for it when first introduced has resulted in a reaction which naturally leads to a low estimate of its value. It must, however, be admitted that a large proportion of the farmers who have used it are fully satisfied that it is a desirable and valuable form of cattle-food, and many would not limit its use to the winter months. Others speak with less confidence of the results of their experience, and are inclined to admit, with those who are not convinced of the utility of the process, that the acidity which is developed to a greater or less extent, in most cases, is decidedly objectionable. Experience at the condensed-milk factories is claimed to be unfavorable to ensilage as food for cows, and some of them refuse to receive milk from farms where it is fed.

That there are great differences in the quality of the ensilage made on different farms, or even in that made on the same farm in different seasons, there can be no doubt, and these differences must be attributed to variations in the conditions under which the ensilage is made, which must result in corresponding modifications of the process of fermentation. When the influence of these varying conditions, which include the peculiarities of the crop, as well as the method of filling the silo, is so well understood that ensilage of a uniform and desired quality can be produced with certainty, the most important objections that are now made to it will be obviated, and it will readily take its place on the farm as a staple article of cattle-food.

My studies of ensilage have for some time past been directed to methods of preventing acidity and securing a desirable degree of uniformity in quality, and thus far the results are, to say the least, encouraging. The experimental silo at the Massachusetts experiment station was made under my direction, on the plan of the wooden silo described above. It was filled in two and a half days with over seventeen tons of fodder-corn, cut in one and a fourth inch lengths, and thoroughly packed as it was put in. A tight cover made of two thicknesses of planed boards and planks was put on, and loaded with barrels of earth that were estimated to give a pressure of over sixty pounds per square foot. For convenience of access to the interior of the mass, a gas-pipe one and a fourth inch in diameter was driven through a hole in the middle of the cover, to the depth of four feet, the upper end being carefully packed to make a tight connection with the planks of the cover, and the upper end was closed with a plug.

When the cover was put on, September 8th, the temperature was 82° Fahr., two feet below the surface. Observations were made from time to time, of the temperature and rate of settling, as recorded in the following table:

DATE.	Depth of ensilage.		Temperature of ensilage four feet from the surface.	Temperature of outside air.
	Ft.	In.	Degrees Fahr.	Degrees Fahr.
September 8th	8	6	82	..
" 9th	7	7	82	..
" 10th	7	2¾	78	..
" 11th	6	9	77	..
" 12th	....		82	62
" 14th	....		84	55
" 15th	5	11½	84	68
" 16th	5	11¼	87	72
" 17th	5	10½	85	69
" 18th	5	9¾	82	59
" 19th	5	9¾	84	..
" 20th	5	9½	84	61
" 21st	5	9¼	84	62
" 22d	5	9	83	56
" 24th	5	9	82	61
" 25th	5	8½	80	58
" 26th	5	8¼	80	50
" 27th	5	7¾	80	50
" 28th	5	7½	80	60
" 29th	5	7¼	79	53
" 30th	5	7¼	78	59
October 1st	5	7⅛	78	50
" 2d	5	7⅛	76	48
" 3d	5	7	76	44
" 4th	5	6⅞	76	43
" 10th	....		68	..
" 27th	....		65	..
November 7th	....		64	..
" 18th	....		59	..
December 3d	....		54	..
" 15th	5	5½	49	22

The weights as applied gave a uniform pressure; but the cover, as will be seen from the table, did not settle at a uniform rate. There was a fall of 5° in temperature during the first three days, then followed a gradual but not uniform rise, until the maximum of 87° was reached at the end of the first week. It will likewise be noticed that a variation of but 5° from the initial temperature occurred during the first three weeks after the cover was put on and weighted, and that the fall in the temperature was not uniform.

Experiments were repeatedly made with samples of ensilage, taken through the tube, from the interior of the silo. The samples obtained on the 9th of September swarmed with bacteria, which were remarkably active and rapidly increasing by self-division. After the first few days the indications of rapid reproduction were not so marked, but the activity of the bacteria was not sensibly diminished until the temperature had fallen below 60°, more than two months after the silo was filled. The variations in temperature and in the rate of settling were undoubtedly connected with the vital activity of the bacteria, but the precise relation of these variations could not be traced.

The real significance of these minute organisms can not be fully appreciated without a review, including a brief history, of the known facts of the process of

Fermentation.—The alchemists were acquainted with ferments and fermentation as early as the thirteenth century, but we need not stop to notice their crude theories in regard to the process. In 1659, Willis, an English physician, presented a theory of fermentation, which was revived by Stahl, the originator of the phlogiston theory, in 1697. According to the theory of these philosophers, ferments had a peculiar motion of their particles which they communicated to the particles of fermentable substances and thus produced fermentation. The discovery of carbonic acid by Black (1752), of oxygen by Priestley (1774), and of the composition of the atmosphere and water by Cavendish (1781), laid the foundation for the experiments of Lavoisier, who attempted a quantitative determination of the changes taking place in the transformation of sugar into alcohol. Gay-Lussac (1815) revised the figures obtained by Lavoisier, by less perfect methods, and made a close approximation to a correct formula. In 1828 Dumas and Boullay pointed out and corrected errors in the formulæ of Gay-Lussac, and in this amended form they were, for many years, accepted as an accurate statement of the phenomena of alcoholic fermentation. Afterward, however, the discovery was made that glycerine and succinic acid are constant products of the process, and the formulæ had to be again corrected. These formulæ, even in their amended form, did not take into the account the yeast which had been recognized as an essential element in the process, and theories were formed to account for its action. Berzelius attributed the influence of yeast to a "catalytic" action—mere contact with the ferment being sufficient to excite fermentation in a fermentable substance without any other direct relation. In 1840 Liebig presented a theory of fermentation which was generally adopted by chemists. He recognized fermentation and putrefaction as essentially similar processes. Albuminoid substances, from the complex arrangement of their molecules, were assumed to be in a state of unstable equilibrium tending to decomposition, and their putrefactive transformations, which were communicated to fermentable substances, were the cause of fermentation. He claimed that "yeast produces fermentation in consequence of the progressive decomposition which it suffers from the action of air and water." Fermentation and putrefaction were claimed to be processes of combustion or oxidation. This theory was more fully elaborated, in 1848, by assigning to the decomposing albuminoid ferments a peculiar molecular motion which communicated to fermentable substances a similar vibration of their particles, and a consequent decomposition. This was in fact but a revival of the theory of Willis and Stahl more than two hundred years before. Notwithstanding its general acceptance by chemists, Liebig's theory failed to recognize one of the essential factors of fermentation, and we must now turn our attention to a brief outline of some of the discoveries which disproved it, and furnished on the other hand a complete and satisfactory explanation of the process.

Leeuwenhoek, in 1680, made the discovery that yeast was composed of minute granules, but, with the imperfect lenses of that time, he failed to determine their real character. Fabroni, in 1787, described the yeast-granules as a vegeto-animal substance; and Astier, as early as 1813, claimed that this ferment was endowed with life, and derived its nourishment from the fermenting materials, thus causing fermentation. About 1838 Cagniard-Latour and Schwann, by independent observations, rediscovered the yeast-granules of Leeuwenhoek, and, by means of the better microscopes at their command, succeeded in proving that they were vegetable cells which were reproduced by budding. Schwann, by a series of ingenious experiments, proved that the germs of the living ferments were conveyed to fermentable substances by the air, and that they were the cause of fermentation, while the free admission of oxygen, under conditions that excluded the germs, was without effect. The experiments of Schwann were, in themselves, sufficient to establish the truth of the physiological theory of fermentation, but they were entirely ignored by Liebig and the advocates of his chemical theory. A complete demonstration of the true theory of fermentation was finally made by Pasteur (1857–'79) in a series of experiments which, from the skill displayed in their conception, and the remarkable accuracy secured in conducting them in accordance with strictly inductive methods, may safely be classed among the most brilliant records in the history of science. He repeated the experiments of his predecessors, invented new methods of investigation by which he was enabled to eliminate all possible sources of error, and answered his opponents by an accumulation of experimental evidence that could not be controverted. He proved that sugar was acted upon by a variety of ferments, each giving its own peculiar product, and that the different kinds of fermentation, properly so called, as the alcoholic, the lactic, the acetic, the viscous, the butyric, and putrefactive, were each the result of the vital activity of distinct and specific organisms.

Ferments are now generally divided into two classes: 1. The so-called soluble or chemical ferments, as acids and diastase, which "invert" cane-sugar and transform it into dextrose, or change starch into dextrin. These soluble ferments, according to Dumas, "always sacrifice themselves in the exercise of their activity," but they do not produce fermentation in the strict sense of the term. 2. The true ferments, which, through the investigations of Pasteur, are now known to be living organisms that produce fermentation as a function of their vital activity. Unlike the soluble ferments, these living organisms increase at the expense of the substances fermented. The true fermentations are therefore purely physiological processes, which are defined by Pasteur as "the direct consequence of the processes of nutrition, assimilation, and life, when they are carried on without the agency of free oxygen," or, "as a result of life without air."

The organized ferments, which belong to the class of fungi, may be divided into two groups, the saccharomycetes, or budding fungi—the active agents of alcoholic fermentation, of which yeast may be taken as the type—and the schizomycetes, or fission fungi, which include the lactic, the butyric, and similar ferments, and the organisms that produce putrefaction; most of them are of the form known as bacteria, and they multiply rapidly by subdivision. It is probable that all the members of both groups propagate by means of spores, as well as by their special processes of budding and fission, but there are many species in which reproduction by spores has not been observed. The living organisms (bacteria) found in samples of fresh ensilage belong to the group of schizomycetes. Thus far no members of the group of saccharomycetes (yeast or alcoholic ferments) have been observed, by me, in samples from the interior of the silo that had not been exposed to the air. When a large surface of ensilage is exposed to the air, after the silo is opened, a variety of ferments may make their appearance, and with them several species of molds, but they are evidently produced from germs derived from the air.

The mold-fungi are not included in the class of ferments, as Pasteur has proved that they act as ferments under exceptional conditions only, and even then they do not produce active fermentation. The alcoholic ferments have been studied more thoroughly than the others, from their importance in the manufacture of beer, wine, etc., but many of the facts developed in their investigation are undoubtedly applicable to other ferments.

From Pasteur's experiments with fruits in an atmosphere of carbonic acid, it appears that any vegetable cells which are capable of extracting their needed supply of oxygen from organic combinations may, by this manifestation of their vital activity, act as ferments, and the true ferments are distinguished from these, not by a difference in their specific action, but from the fact that they are capable of carrying on the functions of nutrition and assimilation with much greater activity without a supply of atmospheric oxygen. Pasteur has likewise proved that the alcoholic ferments develop rapidly in the presence of air, but that their function as ferments is impaired by this ready supply of oxygen. In the absence of air, on the other hand, as in an atmosphere of carbonic acid, they take their supply of oxygen from organic substances, as sugar, and their function as ferments is increased. When the life of the bacteria or other organized ferments is destroyed, the processes of fermentation and putrefaction cease, and this takes place at a temperature of from 122° to 140°, according to observations made in the course of the controversy in regard to spontaneous generation. After the organized ferments are killed, fermentation or putrefaction can not take place until the living ferments are again introduced. The canned articles of food which are now so common in the markets are an illustration of the application of this principle. In their preparation heat is applied, which kills the bacteria—the active agents of fermentation—and the cans are then sealed to prevent the introduction of a fresh supply of germs from the atmosphere. The popular notion that canned articles of food are preserved by excluding the atmospheric oxygen, which has been derived from the application of Liebig's chemical theory of fermentation, is without foundation. The experiments of Schwann, Pasteur, and Tyndall conclusively prove that articles which are peculiarly liable to undergo putrefactive changes, as urine, and an endless variety of vegetable and animal infusions, can be kept without change for months and years when abundantly supplied with free oxygen, if proper precautions are taken to exclude the living organisms that are the real cause of fermentation. These experiments have likewise proved that the germs of the bacteria of fermentation and putrefaction are widely distributed in the air, and the supposed cases of spontaneous fermentation, or putrefaction, are readily explained by the "seeding" of the fermenting substances with germs derived from the atmosphere.

As fermentation is strictly a physiological process, the fermented product may be looked upon as the residuum of what is required in the nutritive processes of the bacteria of fermentation.

The variations in the quality of ensilage, to which attention has already been directed, are readily explained by differences in the condition of the crops, as to maturity and development, and the manner in which it is packed in the silo, all of which must have an influence on the performance of the nutritive functions of the bacteria, and corresponding variations will consequently be presented in the residual or fermented product. As in other cases involving the activity of living organisms the molecular changes taking place under such different conditions can not be expressed in any definite chemical formula.

In advocating these views, Pasteur says: "Originally, when fermentations were put among the class of decompositions by contact-action, it seemed probable, and in fact was believed, that every fermentation had its own well-defined equation, which never varied. In the present day, on the contrary, it must be borne in mind that the equation of a fermentation varies essentially with the conditions under which that fermentation is accomplished, and that a statement of this equation is a problem no less complicated than that in the case of the nutrition of a living being. To every fermentation may be assigned an equation in a general sort of way—an equation, however, which, in numerous points of detail, is liable to the thousand variations connected with the phenomena of life. Moreover, there will be as many distinct fermentations brought about by one ferment as there are fermentable substances capable of supplying the carbon element of the food of that same ferment, in the same way that the equation of the nutrition of an animal will vary with the nature of the food which it consumes. As regards fermentation producing alcohol, which may be effected by several different ferments, there will be, in the case of a given sugar, as many general equations as there are ferments, whether they be ferment-cells properly so called, or cells of the organs of living beings functioning as ferments. In the same way the equation of nutrition varies in the case of different animals nourished on the same food, and it is from the same reason that ordinary wort produces such a variety of beers when treated with the numerous alcoholic ferments which we have described. These remarks are applicable to all ferments alike: for instance, butyric ferment is capable of producing a host of distinct fermentations, in consequence of its ability to derive the carbonaceous part of its food from very different substances, from sugar, or lactic acid, or glycerine, or mannite, and many others. When we say that every fermentation has its own peculiar ferment, it must be understood that we are speaking of the fermentation considered as a whole, including all the accessory products. We do not mean to imply that the ferment in question is not capable of acting on some other fermentable substance, and giving rise to fermentation of a very different kind. Moreover, it is quite erroneous to suppose that the presence of a single one of the products of a fermentation implies the co-existence of a particular ferment. If, for example, we find alcohol among the products of a fermentation, or even alcohol and carbonic-acid gas together, this does not prove that the ferment must be an alcoholic ferment, belonging to alcoholic fermentations, in the strict sense of the term, nor again does the mere presence of lactic acid necessarily imply the presence of lactic ferment. As a matter of fact, different fermentations may give rise to one or even several identical products."

From this statement of the physiological conditions that modify the products of fermentation, it must be seen that uniformity in the quality of ensilage can only be secured by preventing fermentation altogether, or confining it within the narrowest possible limits. This can only be done by killing the bacteria of fermentation in the earliest stages of their activity, which would result in the production of ensilage free from acidity, and closely resembling, in quality, the green fodder from which it is made. If the bacteria can be killed, when the silo is covered and weighted, the inclosed mass of ensilage will be practically preserved under the same conditions as fruits, or vegetables, or meats, are preserved when canned.

The practical question, then, presents itself as to how this can best be accomplished. An extended series of observations on the samples of ensilage from the experimental silo have already been made, to determine the temperature required to kill the bacteria which cause the acid fermentations. This will, undoubtedly, vary somewhat with the kind of produce under treatment, and its condition when put in the silo. Thus far my experiments seem to indicate that a temperature of from 115° to 122°, maintained for one or two hours, will be sufficient to kill the bacteria under the conditions in which they are now placed. In this connection attention must be called to the fact that the time of exposure to a given temperature is quite as important as the temperature itself. A given temperature, continued for several days, may have a better effect than a higher one maintained but a few minutes. Again, a degree of heat that will kill the mature and active bacteria will not, in all probability, kill the germs which may produce succeeding generations of active bacteria if the given temperature is continued but a short time.

From the results recorded in the table, it is reasonable to infer that an initial temperature sufficiently high to kill the active bacteria would be continued for several weeks, and this, in all probability, would insure the destruction of any successive generations of bacteria that might be produced from the germs that had not been killed. For this purpose, silos with walls of wood may have an important advantage over those constructed of materials that are better conductors of heat.

In filling the silo, all writers on ensilage agree in giving directions which are based on Liebig's chemical theory of fermentation. The thorough packing of the ensilage as it is put in and the rapid filling of the silo are points that are strongly urged to prevent, as far as possible, the exposure of the fodder to the oxygen of the atmosphere, which is assumed to be the exciting cause of fermentation. In the light of the physiological theory of fermentation it will, however, be readily seen that the living ferments, which produce acidity, are buried with the fodder as it is packed in the silo, and the exclusion of the atmosphere, as Pasteur has proved, is a condition that favors fermentation, the oxygen itself not being directly concerned in the process. When the greatest care is taken in packing the ensilage, the temperature of the mass will often rise above 100° Fahr. (I have observed a temperature of 105° under such conditions); and, when the time of filling is extended over several days, a considerably higher temperature may be developed.

There are good reasons for the belief that, with less packing of the fodder when put in the silo, the time of filling may be safely extended until the temperature rises to a point that is fatal to the bacteria, and this is the probable explanation of the reported cases in which the ensilage is said to be "sweet," or free from acidity.

The efficient cause of this preliminary heating process, or the changes in the fodder involved in its development, have not been determined by experiment, and we do not know the precise conditions under which the best results may be obtained.

In the present state of our knowledge of the subject, the most desirable method may be to fill the silo without any packing, beyond that produced by the weight of the superincumbent mass, and then allow it to remain until the desired temperature is reached, before putting on the cover and weights. The best method can only be determined by carefully conducted experiments, that are made with a full knowledge of the different conditions that may have an influence in modifying the results. It can not, however, be doubted that sour ensilage can only be produced by conducting the process so that the temperature does not rise above the point that is fatal to the bacteria (probably 115° to 120°).

Observations on temperature have been generally neglected when silos were filled, and we, therefore, lack the necessary data for determining the precise temperature required to prevent fermentation, or the most favorable conditions for producing it, from the results of practical experience.

Several cases have been reported to me in which the fodder at the time of filling the silo was supposed to be "spoiled" from the high temperature developed before it was covered and weighted, but on opening these silos, after several months, the result uniformly obtained was ensilage of the best quality, free from acidity. But a single case has, however, come to my knowledge, in which the exact temperature was recorded at the time of filling the silo, when the resulting product was *sweet* ensilage. Mr. George Fry, of England, reports the results of his experience the past season, which is of particular interest in connection with my experiments with ensilage. He filled a silo with *Trifolium incarnatum* (crimson clover), "rough grass," and "clover and rye grass," between the 7th and 30th of June, the temperature recorded at the time of covering being 132° six feet from the surface. The cover was weighted with twelve inches of sand. On July 11th, and again on the 17th, the cover was taken off, and the silo was filled with "meadow-grass," to make up for the loss in settling. The temperature observed at these dates was 140° at a depth of six feet. In another silo, filled with clover and "rye-grass" and "meadow-grass," between June 30th and July 11th, when the cover was put on and weighted, the recorded temperatures were (July 7th) 149° and (July 14th) 158°. The first-mentioned silo was opened October 25th, and the ensilage is described as "of a brown color, and of a sweet, luscious odor, *free from acidity*, very much resembling that of ordinary hay," and it was at once eaten by cattle, sheep, and horses, with apparent relish.

Mr. James Chaffee, of Wassaic, New York, informed me that from unavoidable delays in filling his silo with fodder-corn, in 1882, the ensilage became so "hot," before it was covered and weighted, that he feared it would be entirely spoiled; but, when it was opened in the fall, the fodder was perfectly preserved, of a brown color, and sweet, delicious odor, without the slightest indication of acidity. His cows ate it with such a decided relish that he had no hesitation in saying it was the best ensilage he had ever made. Last year he followed the usual method of rapid filling and thorough packing, and his ensilage, when opened, was very sour, and in quality decidedly inferior to that made in 1882. Other cases of a similar import might be given to show that a temperature sufficiently high to kill the bacteria and prevent fermentation can readily be obtained in the process of filling the silo, and that the ensilage under such conditions is of much better quality than when the temperature is kept within the range that is favorable for the development of the acid ferments.

Experiments are now needed to determine the exact temperatures required for destroying the organisms that cause fermentation, under the different conditions presented at the time of filling the silo, and the special methods of practice that may be desirable in the treatment of different crops. This field of experimental investigation is of the greatest practical interest, and we may safely predict that the thermometer will soon be found as indispensable in securing the best results in the ensilage of green fodder as it is now in the various processes of the dairy.

GEOGRAPHY AND THE RAILROADS.

BY DR. J. JASTROW.

IT should be regarded as a prominent purpose, in any scientific description of the earth, to point out how geographical influences have impressed their mark on organic and inorganic nature and in the field of human civilization. Alexander von Humboldt set an admirable example of the manner in which this should be done when he studied the relations existing between the geographical structure and the vegetation of different regions. Remarks upon the influence of soil and climate on plant-life are as old as the study of botany itself, but a scientific plant-geography has been developed only since Humboldt took the subject up. It has been followed by the study, upon similar principles, of geographical influences on animal life ; and since Carl Ritter's time the diversified aspects of human civilization have been subjects of unceasing study from similar points of view. In this study, religious ideas, personal, civil, and legal rights, customs, and all the features of social and political life have been examined with reference to the influence of geographical conditions in shaping and modifying them. At first sight the management of railroads would seem to be one of the least amenable of all subjects to this method of consideration. Originating and brought to a considerable degree of perfection in England, the railroad system has been transplanted bodily into other countries, without considering any modifications of its methods necessary except in obedience to the most imperative exceptional physical requisitions. Yet modifications and individual differences of character have been impressed upon the railroad service of different countries by the silent working of varying geographical conditions. These differentiations were especially studied by the late Max Maria von Weber, whose theories respecting them are expounded in a posthumous work recently published in Berlin, in which he has considered the subject under the headings of the "Geography of Railroad Life" and the "Physiognomical Aspects of the Railroad Systems of Different Civilized Nations."

We may in the first place regard the manner in which the function and service of the railroad system are dependent upon the form and relations of a country's boundaries. The construction of the railways in insular countries is governed wholly by mercantile considerations, while, in countries whose boundaries are exposed, military and political objects claim prominence. Thus, an English railway-map affords a most accurate picture of the relations of the country to production and trade, and of the office of the railroads as the medium of communication between the great coal and iron fields on one side and the world's mart on the Thames on the other side. But the ramifications of the German system would be incomprehensible to one who did not consider that, equally with mercantile requirements, the political interests of a congeries of small states, the central situation of the empire among a number of jealous and ambitious powers, and the great military deficiency of the absence of a natural eastern boundary, have exerted a dominant influence in its arrangement. The clearly mercantile features of the organization of the railroads in states whose natural boundaries give them security are thus neither more nor less appropriate than the military and administrative methods prevalent in states whose political integrity is precarious; and we have, in the degree to which additional defensive resources are needed, the first element of individualization according to geographical conditions.

The shape and extension, though the most obvious, constitute only one of the features in which the railroad system is affected by geographical conditions. Regarding the lines in the mercantile aspect, we find that the relative importance of their freight and passenger traffic is likewise subject to such influences. While in Germany freight is the all-important element in estimating the value of the business done by the railroads, and it would be thought folly to depend chiefly on the receipts from passengers, this is not the case in all countries. Herr von Weber gives a table of the relative value of the passenger and freight business of six countries, from which the results are deduced that in Austria it is as 1 to 4; in Russia, as 1 to 3·2; in Prussia, as 1 to 2·7; in England, as 1 to 1·3; in Italy, as 1 to 0·9; and in Denmark, as 1 to 0·5. In the first three countries here named, the excess is very largely in favor of the freight traffic; in England, the values of the two kinds are more nearly equal, while in Italy and Denmark the excess is on the side of the passenger traffic. The first three countries are continental, the last three are maritime. Where there are abundant water-ways to compete with the railroads, the freight, which seeks the easiest routes, goes to them, and the railroads have to rely more largely upon passengers; where water-ways are more rare, as on the great Continental plains, the freight is of necessity carried on the railroads, and they find in it the source of their most lucrative business, by the side of which the passenger traffic may sink into relative insignificance.

With equal acumen Herr von Weber has remarked a differentiation in conformity to geographical diversities in the means and apparatus which railroads employ in the performance of their work. At first sight it would appear that the wagons in which the goods are carried, which to-day are found on the Atlantic coast and in a few days more are removed to the borders of Asia, which in going scale Alpine ridges, and are before long to be returned to the ocean on routes passing through and under the mountains by tunnels, should be of uniform construction. Herr von Weber divides the equipment and appurtenances of a railway line into two groups, the first of which includes those articles that are stationary or which circulate only within a limited area, and the second those that are liable to be moved over the whole circuit of an extensive and complicated system. To the former class, of fixed elements, he assigns the road-bed and superstructure and all their accessories; to the other class, or that of movable properties, belong the wagons. Between the two classes are the locomotives, which only rarely go outside of the particular system to which they belong. "While the fixed organs," he says, "answer their purposes the more completely the more exactly they are adapted in individual character to the conditions of the place, the movable properties are more serviceable in proportion as they are constructed so as to be susceptible of a more general adaptation." The former elements are wholly subject to the influence of geographical conditions, and are conformed to the diversities of provincial and even of local circumstances and requirements; the latter set particular geographical conditions at defiance, and only do homage to them at the line which separates districts between which no direct intercourse by railway exists. On the East Prussian bogs sleepers will be required of a different character from those which may be used on the sands of the marches; French locomotives are different in structure and performance from those used in Germany. But the freight-wagons are the same over the whole Continent; and it is only after crossing the ocean that the question of adapting the rolling stock to different conditions becomes a living one.

The following out of these principles in their particular applications would carry us too deeply into details. A single example of the manner in which local conditions may rule can be drawn from the history of early railway-building in the United States. Here "were made in incredible haste those lines that stretch toward the West, over extensive tracts of wild land, plains, river-bottoms, and prairies, pushing through the forest which afforded the principal part of the material for their construction. Thus arose, as the direct result of local conditions, that method of construction the rapidity and temporary character of which received the specific name of 'American.' The substructure was hastily thrown up, a rude mass of loose earth and rarely well ballasted, while the superstructure was built with long stringers of wood which in the scarcity of iron could be armored with only a thin, flat strap-rail. With a superabundance of wood, extensive depressions of the ground were crossed with trestle-work instead of embankments; the excellent quality of the wood permitted the rapid erection of high, broad-spanned wooden bridges; and the forest also furnished the material for the construction of wooden station-houses, water-stations, turn-tables, and everything else that could be made of that material." Now, with the growing scarcity of wood, and abundance of iron and steel, and the greater facility of transportation afforded by the railroads themselves—heavy steel rails, firm embankments, iron and stone bridges, and more substantial buildings, are taking the place of the former flimsy structures, and the "American" type of railway-structure as above described has nearly become a thing of the past.

Still, having the earlier American railroads in view, Herr von Weber shows that the solid wagons of European construction could not be trusted to the insecure foundations of these imperfectly finished tracks. The stiff carriages must be made more flexible, and thus originated the adjustable trucks of the American cars and locomotive. The locomotive was furnished with an armor in the shape of the raking cow-catcher or the plow-shaped pilot to remove from the track logs, cattle, or whatever else might be found upon it; with a head-light to illuminate the track; with a bell to give warning at road-crossings and places where the public were exposed to danger; and with a spark-catcher, required by the former universal use of wood as fuel for the furnace. In this manner the physiognomy of the American locomotive was the outgrowth of the novel physical and geographical conditions of the new continent.

With these and other studies conducted in a similar spirit, of the problems which the geographical configuration of each country imposes upon its railway service, and the means which it permits or indicates for attaining a solution of them, Herr von Weber has undertaken to lay a scientific basis for his observations on the physiognomy of the railway systems among the principal civilized nations. He also offers some remarks on the special aspects of the service in different states; and in this category he has not omitted to indicate a geographical influence in points the determination of which would be regarded as wholly casual were not the evidence on the other side so strong. The traveler on the English railways must have remarked the quiet and self-sufficient manner in which every person, from the train-master, or conductor, to the porter, performs his duties; it is pleasant to have these observations not only confirmed but also shown to be the sign of just that which ought to be, by a writer who is an authority on the art of traveling. The English railway service owes its "physiognomy" to two circumstances: first, to the fact that England is the native country of the railway, in which the very people among whom the new institution grew up were intrusted with its working, and furnished a personal service "to the manor born"; and, secondly, to the purely mercantile character which, by the natural features and situation of the island, the railway administration is able to maintain. The business at an English railway-station is done in the same style as in an old mercantile house, where, instead of special directions having to be given all the time, it is understood by every one that he knows what his duties are and how he is expected to perform them. The case is different in Germany, where the railway system was transplanted already made, and it was necessary to create a personal service, and where the configuration of the boundaries had its influence, not only on the laying out of the lines, but also on the whole system of administration. It would not have been possible to secure certainty in the management if there had not been at hand a host of officers trained under military discipline, who, unqualified to act freely, knew well how to obey. An English engineer has described as the basis of the German service intelligent command and strict obedience. English management expects its subordinates to be intelligent enough to do the right thing without a special order. "If we should characterize 'intelligent self-reliance' as the genius of the English system, 'organized instruction' of the French, and 'skillful daring' of the American, that of the German is unquestionably exact discipline."

Herr von Weber brings out many other features in illustration of his theory, and, without assuming that he has made even an approach to exhausting the subject, summarizes his conclusions in the remark that "the railway system of every region having distinctly marked geographical characteristics appears to be a product of its physical structure, soil, and climate, just as its flora and fauna, except that man has stepped in as an intervening agent between the natural conditions and their product. At some future period, when railways shall have spread over the whole earth, account will be taken in the particular adaptation of the new institutions of yet more widely differing and more distinctly marked geographical conditions, and the forms they assume will become so diversified that we shall be able to speak of the "geography of railway-life as we now speak of the geography of the animal-world and of the plant-world."—*Translated for the Popular Science Monthly from Das Ausland.*

THE LIFE-WORK OF PASTEUR.*

BY HIS SON-IN-LAW.

LOUIS PASTEUR passed his childhood in a small tannery which his father had bought in the city of Arbois, in the department of the Jura, to which he removed from the ancient city of Dôle, in the same department, where he was born. When Louis became of suitable age, he was sent to the communal school, and was so proud of the fact that, though he was the smallest of the pupils, he went on the first day with his arms full of dictionaries away beyond his years. He does not appear, as yet, to have been a particularly diligent student. He was as likely to be found drawing a portrait or a sketch—and the walls of several Arboisian houses bear testimonies of his skill in this art—as studying his lesson, and to go a-hunting or a-fishing as to take the direct way to the school. Yet the principal of the college was ready to predict that it was no small school like this one, but some great royal institution, that was destined to enjoy his services as a professor. As there was no Professor of Philosophy in the college at Arbois, young Pasteur went to Besançon to continue his studies. Here, in the chemistry-class, he so vexed Professor Darlay with his frequent and searching questions, that the

* From a volume under this title, translated from the French by Lady Claude Hamilton. In press of D. Appleton & Co. The present article is translated and abridged directly from the French by W. H. Larrabee.

old gentleman was disconcerted, and declared it was his business to question the pupil, not Pasteur's to question him. Pasteur then had recourse to a pharmacist in the town who had gained some distinction in science, and took private lessons in chemistry from him. He fared better at the École Normale, where he had Balard for a teacher, and also enjoyed the instructions of Dumas, with whom he formed a lifelong friendship at the Sorbonne.

Pasteur's first important investigation was suggested at about this time, by an observation of Mitscherlich, the German mineralogist, of a difference in the behavior toward polarized light of the crystals of paratartrate of soda and ammonia and tartrate of soda and ammonia, bodies identical in composition and external form and other properties. Pasteur discovered differences in the form of the crystals and the molecular structure of the two bodies that had escaped detection, and was led to consider that all things may be divided into two categories: those having a plane of symmetry—that is, capable of being divided so that the parts on either side of the plane of division shall be equal and identical—or symmetrical bodies; and dissymmetrical bodies, or those not capable of being so divided. Occupied with the idea that symmetry or dissymmetry in the molecular arrangement of any chemical substance must be manifested in all its properties capable of showing the quality, he pursued his investigations till he reached the conclusion that an essential difference in properties as to symmetry exists between mineral and dead matter and matter in which life is in course of development, the former being symmetrical, the latter unsymmetrical.

Pasteur's wedding-day came on while he was engaged in this investigation. He went, not to the marriage-feast, but to his laboratory, and had to be sent for when all was ready.

With his observing powers quickened by his studies of symmetry and dissymmetry, Pasteur went to the researches with which his life has been identified, beginning with his studies in fermentation. Liebig's theory, that fermentation is a change undergone by nitrogenous substances under the influence of the oxygen of the air, ruled at the time, and the observations of Schwann and Cagniard-Latour on the yeast-plant were overlooked or regarded as exceptional. M. Pasteur continued the investigation of the alcohol-producing yeast-plant, and, cultivating it in suitable solutions, proved that it possessed organizing power ample to account for the phenomena. He found a similar organism—minute cells or articulations narrowly contracted in the middle—active in the lactic fermentation, capable of cultivation; and another organism, a vibrion, full of motion, living singly or in chains, working in the butyric fermentation.

The butyric vibrion was found to work quite as vigorously and with as much effect when no air was added to the decoctions, and in fact to perish with a stoppage of the formation of butyric acid when air was too freely supplied. Reverting to the development of the yeast-plant and the alcoholic fermentation, he found that they also went on best when free air was excluded. Thus, Liebig's dictum, that fermentation is the result of the action of oxygen, must be reversed or abandoned. The organisms working these processes were given the class-name of *anærobes*, or beings that live without air. The French Academy's impressions of the results of Pasteur's work were spoken by Dumas, who said to him, "In the infinitely little of life you have discovered a third kingdom to which belong those beings which, with all the prerogatives of animal life, have no need of air to live, and find the heat they require in the chemical decompositions they provoke around them." The place of the organisms in the economy of Nature had not yet been fixed, but Pasteur was able to declare: "Whether the progress of science makes the vibrion a plant or an animal, is no matter; it is a living being endowed with motion, that lives without air and is ferment." It would be mere repetition to follow the experiments in putrefaction, where Liebig had denied that living organisms have any place, into which Pasteur carried the same methods and obtained the same results as in the case of fermentation. He proved that living organisms have all to do with it.

After M. Pasteur had been collecting his proofs for twenty years, Dr. Bouillaud sharply asked in the Academy: "How are your microscopic organisms disposed of? What are the ferments of the ferments?" He, as well as Liebig, believed the question could not be answered. Pasteur proved, by a series of the parallel experiments of the kind that have since become familiar, that oxygen deprived of its germs is incapable of producing fermentation or putrefaction, even after years, while the same substances are acted upon at once if the germs are present; and then answered that the ferments are destroyed by a new series of organisms—*ærobes*—living in the air, and these by other ærobes in succession, until the ultimate products are oxidized. "Thus, in the destruction of what has lived, all is reduced to the simultaneous action of the three great natural phenomena—fermentation, putrefaction, and slow combustion. A living being, animal or plant, or the *débris* of either, having just died, is exposed to the air. The life that has abandoned it is succeeded by life under other forms. In the superficial parts accessible to the air, the germs of the infinitely little ærobes flourish and multiply. The carbon, hydrogen, and nitrogen of the organic matter are transformed, by the oxygen of the air and under the vital activity of the ærobes, into carbonic acid, the vapor of water, and ammonia. The combustion continues as long as organic matter and air are present together. At the same time the superficial combustion is going on, fermentation and putrefaction are performing their work, in the midst of the mass, by means of the developed germs of the anærobes, which not only do not need oxygen to live, but which oxygen causes to perish. Gradually the phenomena of destruction are at last accomplished through the work of latent fermentation and slow combustion. Whatever animal or vegetable matter is in the open air or under the ground, which is always more or less impregnated with air, finally disappears. The processes can be stopped only under an extremely low temperature, . . . in which the microscopic organisms can not flourish. These facts come in to fortify the still new ideas of the part which the infinitely little play as masters of the world. If their work, always latent, were suppressed, the surface of the globe, overloaded with organic matters, would become uninhabitable."

Pasteur extended his observations to the acetic fermentation, or conversion of alcohol into vinegar, in which he found an organism, the *Mycoderma aceti*, actively promoting a process of oxidation. Liebig had attributed this fermentation, also, to the presence of an albuminoid body in process of alteration, and capable of fixing oxygen. He knew of the plant called "mother," but regarded it as an outgrowth of the fermentation, and in no sense the cause. Pasteur proved, by experiments that left no room for doubt—the prominent characteristic feature in all his investigations—that the plant is the real agent in producing the fermentation. He eliminated from his compositions the albuminoid matter, which Liebig had declared to be the active agent, and replaced it with crystallizable salts, alkaline phosphates, and earths; then, having added alcoholized water, slightly acidulated with acetic acid, he saw the mycoderm develop, and the alcohol change into vinegar. Having tried his experiments in the vinegar-factories at Orleans, he became so sure of his position that he offered to the Academy, in one of its discussions, to cover with the mycoderm, within twenty-four hours, from a few hardly-visible sowings, a surface of vinous liquid as extensive as the hall in which they were meeting.

Liebig allowed ten years to pass after Pasteur's investigations, and then published a long memoir traversing his conclusions. Pasteur visited Liebig at Munich, in 1870, to discuss the matter with him. The German chemist received him courteously, but excused himself from the discussion, on the ground of a recent illness. The Franco-German War came on; but, as soon as it was over, Pasteur invited Liebig to choose a committee of the Academy, and furnish a sugared mineral liquid. He would produce in it, before them all, an alcoholic fermentation in such a way as to establish his own theory and contradict Liebig's. Liebig had referred to the process of preparing vinegar by passing diluted alcohol through wooden chips, as one in which no trace of a mycoderm could be found, but in which the chips appeared perfectly clean after each operation. It was, in fact, impossible that there should be any mycoderm, because there was nothing on which it could be fed. Pasteur replied to this: "You do not take account of the character of the water with which the alcohol is diluted. Like all common waters, even the purest, it contains ammoniacal salts and mineral matters that can feed the plant, as I have directly demonstrated. You have, moreover, not carefully examined the surface of the chips with the microscope. If you had, you would have seen the little articles of the *Mycoderma aceti*, sometimes joined into an extremely thin pellicle that may be lifted off. If you will send me some chips from the factory at Munich, selected by yourself in the presence of its director, I will, after drying them quickly in a stove, show the mycoderm on their surface to a committee of the Academy charged with the determination of this debate." Liebig did not accept the challenge, but the question involved has been decided.

The experiments in fermentation led by natural steps to the debate on spontaneous generation, in which Pasteur was destined to settle a question that had interested men ever since they lived. The theory that life originates spontaneously from dead matter had strong advocates, among the most earnest of whom was M. Pouchet. He made a very clear presentment of the question at issue, saying: "The adversaries of spontaneous generation assume that the germs of microscopic beings exist in the air and are carried by it to considerable distances. Well! what will they say if I succeed in producing a generation of organized beings after an artificial air has been substituted for that of the atmosphere?" Then he proceeded with an experiment in which all his materials and vessels seemed to have been cleansed of all germs that might possibly have existed in them. In eight days a mold appeared in the infusion, which had been put boiling-hot into the boiling-hot medium. "Where did the mold come from," asked M. Pouchet, triumphantly, "if it was not spontaneously developed?" "Yes," said M. Pasteur, in the presence of an enthusiastic audience, for Paris had become greatly excited on the subject, "the experiment has been performed in an irreproachable manner as to all the points that have attracted the attention of the author; but I will show that there is one cause of error that M. Pouchet has not perceived, that he has not thought of, and no one else has thought of, which makes his experiment wholly illusory. He used mercury in his tub, without purifying it, and I will show that that was capable of collecting dust from the air and introducing it to his apparatus." Then he let a beam of light into the darkened room, and showed the air full of floating dust. He showed that the mercury had been exposed to atmospheric dust ever since it came from the mine, and was so impregnated and covered with it as to be liable to soil everything with which it came in contact. He instituted experiments similar to those of M. Pouchet, but with all the causes of error that had escaped him removed, and no life appeared. The debate, which continued through many months, and was diversified by a variety of experiments and counter-experiments, was marked by a number of dramatic passages and drew the attention of the world. M. Pasteur detected a flaw in every one of M. Pouchet's successful experiments, and followed each one with a more exact experiment of his own, which was a triumph for his position. Having shown, by means of bottles of air collected from different heights in a mountain-region, that the number of germs in the air diminishes with the elevation above the earth, and that air can be got free from germs and unproductive, M. Pasteur asserted decisively: "There is no circumstance now known that permits us to affirm that microscopic beings have come into the world without germs, without parents like themselves. Those who affirm it have been victims of illusions, of experiments badly made, and infected with errors which they have not been able to perceive or avoid. Spontaneous generation is a chimera." M. Flourens, Perpetual Secretary of the Academy, said: "The experiments are decisive. To have animalcules, what is necessary, if spontaneous generation is real? Air and putrescible liquids. Now, M. Pasteur brings air and putrescible liquids together, and nothing comes of it. Spontaneous generation, then, is not. To doubt still is not to comprehend the question." There were, however, some who still doubted, and to satisfy them M. Pasteur offered, as a final test, to show that it was possible to secure, at any point, a bottle of air containing no germs, which would, consequently, give no life. The Academy's committee approved the proposition; but M. Pouchet and his friends pleaded for delay, and finally retired from the contest.

The silk-raising industry of the south of France was threatened with ruin by a disease that was destroying the silk-worms, killing them in the egg, or at a later stage of growth. Eggs, free from the disease, were imported from other countries. The first brood flourished, but the next one usually fell victims to the infection, and the malady spread. All usual efforts to prevent it or detect its cause having failed, a commission was appointed to make special investigations, and M. Pasteur was asked to direct them personally. He did not wish to undertake the work, because it would withdraw him from his studies of the ferments. He, moreover, had never had anything to do with silk-worms. "So much the better," said Dumas. "You know nothing about the matter, and have no ideas to interfere with those which your observations will suggest." Theories were abundant, but the most recent and best authorities agreed that the diseased worms were beset by corpuscles, visible only under the microscope. He began his investigations with the idea that these corpuscles were connected with the disease, although assurances were not wanting that they also existed in a normal condition of the silk-worm. M. Pasteur's wife and daughters, and his assistants in the normal school, associated themselves with him in the studies, and became, for the time, amateur silk-raisers. He studied the worms in every condition, and the corpuscles in every relation, for five years. He found that there were two diseases—the contagious, deadly *pébrine*, the work of the corpuscles, and *flachery*, produced by an internal organism; and "became so well acquainted with the causes of the trouble and their different manifestations that he could, at will, give *pébrine* or *flachery*. He became able to graduate the intensity of the disease, and make it appear at any day and almost at any hour." He found the means of preventing the disorders, and "restored its wealth to the desolated silk district." The cost of this precious result was a paralysis of the left side, from which he has never fully recovered.

As early as 1860 M. Pasteur expressed the hope that he might "be able to pursue his investigations far enough to prepare the way for a more profound study of the origin of diseases." Reviewing, at the conclusion of his "Studies on Beer," the principles which had directed his labors for twenty years, he wrote that the etiology of contagious diseases was, perhaps, on the eve of receiving an unexpected light. Robert Boyle had said that thorough understanding of the nature of fermentations and ferments might give the key to the explanation of many morbid phenomena. The German doctor, Traube, had in 1864 explained the ammoniacal fermentation of urine, by reference to Pasteur's theory. The English surgeon, Dr. Lister, wrote in 1874 to Pasteur that he owed to him the idea of the antiseptic treatment of wounds which he had been practicing since 1865. Professor Tyndall wrote to him, in 1876, after having read his investigations for the second time: "For the first time in the history of science we have a right to entertain the sure and certain hope that, as to epidemic diseases, medicine will shortly be delivered from empiricism and placed upon a really scientific basis. When that great day shall come, mankind will, in my opinion, recognize that it is to you that the greatest part of its gratitude is due."

The domestic animals of France and other countries had been subject to a carbuncular disease, like the malignant pustule of man, which took different forms and had different names in different species, but was evidently the same in nature. A medical commission had, between 1849 and 1852, made an investigation of it and found it transmissible by inoculation from animal to animal. Drs. Davaine and Rayer had, at the same time, found in the blood of the diseased animals minute filiform bodies, to which they paid no further attention for thirteen years, or till after Pasteur's observations on fermentation had been widely spread. Then, Davaine concluded that these corpuscles were the source of the disease. He was contradicted by MM. Jaillard and Leplat, who had inoculated various animals with matter procured from sheep and cows that had died of the disease without obtaining a development of the bodies in question. Davaine suggested that they had used the wrong matter, but they replied that they had obtained it direct from an unmistakable source. Their views were supported by the German Dr. Koch and M. Paul Bert. At this point, M. Pasteur stepped in and began experiments after methods which had served him as sure guides in his studies of twenty years. They were at once simple and delicate. "Did he wish, for example, to demonstrate that the microbe-ferment of the butyric fermentation was also the agent in decomposition? He would prepare an artificial liquid, consisting of phosphate of potash, magnesia, and sulphate of ammonia, added to the solution of fermentable matter, and in the medium thus formed would develop the microbe-ferment from a pure sowing of it. The microbe would multiply and provoke fermentation. From this liquid he would pass to a second and then to a third fermentable solution of the same composition, and so on, and would find the butyric fermentation appearing in each successively. This method had been sovereign in his studies since 1857. He now proposed to isolate the microbe of blood infected with carbuncle, cultivate it in a pure state, and study its action on animals." As he was still suffering from a partial paralysis, he employed M. Joubert to assist him and share his honors. In April, 1877, he claimed before the Academy of Sciences that he had demonstrated, beyond the possibility of a reply, that the bacillus discovered by Davaine and Rayer in 1850 was in fact the only agent in producing the disease. It still remained to reconcile the facts adduced by Messrs. Jaillard and Leplat with this assertion. The animals which they had inoculated died, but no bacteria could be found in them. M. Paul Bert, in similar experiments, had found a disease to persist after all bacteria had been destroyed. An explanation of the discrepancy was soon found.

The bacteria of carbuncle are destroyed as soon as putrefaction sets in. The virus with which these gentlemen had experimented was taken from animals that had been dead twenty-four hours and had begun to putrefy. They had inoculated with putrefaction, and produced septicæmia instead of carbuncle. All the steps in this line of argument were established by irrefragable proof. M. Pasteur afterward had a similar controversy with some physicians of Turin, at the end of which they shrank from the test experiment he offered to go and make before them. "Remember," shortly afterward said a member of the Academy of Sciences to a member of the Academy of Medicine, who was going—in a scientific sense—to "choke" M. Pasteur, "M. Pasteur is never mistaken."

Having discovered and cultivated the microbe that produces hen-cholera, Pasteur turned his attention to the inquiry whether it would be possible to apply a vaccination to the prevention of these terrible diseases of domestic animals. He found that he could transplant the microbe of hen-cholera to an artificially prepared medium and cultivate it there, and transplant it and cultivate it again and again, to the hundredth or even the thousandth time, and it would retain its full strength—provided too long an interval was not allowed to elapse between the successive transplantations and cultures. But if several days or weeks or months passed without a renewal of the medium, the culture being all the time exposed to the action of oxygen, the infection gradually lost in intensity. A virus was produced of a strength that would make sick, but not kill. Hens were inoculated with this, and then, after having recovered from its effects, with virus of full power. It made them sick, but they recovered. A preventive of hen-cholera had been found. In the experiments upon the feasibility of applying a similar remedy to carbuncular diseases, it was necessary to ascertain whether or not animals, which had once been stricken with the disease, were exempt from liability to a second attack. The investigator was met at once by the formidable difficulty that no animals were known to have recovered from a first attack, to serve as subjects for trial. A fortunate accident in the failure of another investigator's experiment gave M. Pasteur a few cows that had survived the disease. They were inoculated with virus of the strongest intensity, and were not affected. It was demonstrated, then, that the disease would not return. M. Pasteur now cultivated an attenuated carbuncle-virus, and, having satisfied himself that vaccination with it was effective, declared himself ready for a public test-experiment. Announcing his success to his friends, he exclaimed in patriotic self-forgetfulness, "I should never have been able to console myself, if such a discovery as I and my assistants have just made had not been a French discovery!"

Twenty-four sheep, a goat, and six cows were vaccinated, while twenty-five sheep and four cows were held in reserve, unvaccinated, for further experiment. After time had been given for the vaccination to produce its effect, all of the animals, sixty in number, were inoculated with undiluted virus. Forty-eight hours afterward, more than two hundred persons met in the pasture to witness the effect. Twenty-one of the unvaccinated sheep and the goat were dead, and two more of the sheep were dying, while the last one died the same evening; the unvaccinated cows were suffering severely from fever and œdema. The vaccinated sheep were all well and lively, and the vaccinated cows had neither tumor nor fever of any kind, and were feeding quietly. Vaccination is now employed regularly in French pastures; five hundred thousand cases of its application had been registered at the end of 1883; and the mortality from carbuncle has been reduced ten times.

There is no need to follow M. Pasteur in his further researches in the *rouget* of pork, in boils, in puerperal fever, in all of which, with other maladies, he has applied the same methods with the same exactness that have characterized all his work. His laboratory at the École Normale is a collection of animals to be experimented upon—mice, rabbits, Guinea-pigs, pigeons, and other suitable subjects, with the dogs upon which he is now studying hydrophobia most prominent. There is nothing cruel in his work. His inoculations are painless, except as the sickness they induce is a pain, and the suffering they cause is as nothing compared with that which they are destined to save. On this subject he himself has remarked in one of his lectures: "I could never have courage to kill a bird in hunting; but, in making experiments, I have no such scruples. Science has a right to invoke the sovereignty of the end."

What he has done, M. Pasteur regards as only the beginning of what is to be accomplished in the same line. "You will see," he has sometimes said, "how this will grow as it goes on. Oh, if I only had time!"

CLEAN DRINKING-WATER.

By EDWIN J. HOWE, M. D.

AMONG the subjects that claim the study of the sanitarian, there is none that has a closer relation to public health, and hence none more worthy of careful investigation, than the water we drink. Receiving it, as we do, from varied sources—from spring, well, brook, or river—its character varies greatly; and, while in its purity bringing with it refreshment and health, in a polluted condition it too often carries in its wake disease and death.

The study of sanitary science during the last few years has demonstrated beyond a doubt that many severe epidemics have arisen from the use of impure water, as the reading of Witthaus, Parkes, Buck, Flint, Pavy, or other writers on the subject, will clearly prove.

When we remember that water has greater solvent properties than any other liquid known, we can readily understand how it often becomes such a disease-spreading medium. Besides carrying with it vegetable and organic impurities in suspension, it dissolves many of those that are the most subtile and dangerous to the human organism. The dangers of drinking impure water may best be presented in a few quotations from well-known authorities.

Pavy, in "Food and Dietetics," says: "Water has much to answer for in the causation of disease. . . . It" (polluted water) "is acknowledged to be one of the common causes of dysentery, and has been alleged, when derived from a marshy district, to be capable of inducing malarial fever and its concomitant, enlargement of the spleen. . . . Typhoid has been frequently communicated through the medium of water. Milk, adulterated with polluted water, has been the cause of serious outbreaks of fever." Parkes, in his "Manual of Practical Hygiene," shows that the baneful effects of polluted water were known to the ancient Greeks. Hippocrates, who was born 460 B. C., asserts, "The spleens of those who drink the water of marshes become enlarged and hard." Parkes considers typhoid, cholera, scarlet fever, and diphtheria, and some forms of skin-disease, "likely to be propagated by means of water."

Polluted water that has been frozen, though improved by the freezing, does not become innocuous. "Ice and snow may be the means of conveying malarial poisons to places at a distance," by distributing organic matter held in suspension. Dr. Edwards, of Montreal, found two grains of organic matter to the gallon of melted shore-ice, and one grain to the gallon of river-ice. One writer, Pavy, says, "River water and the water of shallow wells should always be regarded with suspicion," and he adds, "There is evidence to show that the most serious consequences have arisen from the consumption of impure water." Buck, in "Hygiene and Public Health," says, "The weight of evidence and authority favors the idea that the drinking-water may become the cause of disease, and in drinking a polluted water one always runs more or less risk." The River Pollution Commission of London, after analyzing water from different sources, reported dangerous "river-water to which sewage gains access."

The conclusion from the above quotations is, not that one should abstain from drinking water on account of the difficulty in obtaining it pure, but that proper precautions should be observed to obtain it pure. Water is Nature's means of slaking thirst, and with its refreshing properties combines valuable therapeutic qualities.

An excellent article, published in the "Boston Journal of Chemistry," in treating of the curative value of water says: "We notice the salutary influence of water-drinking upon many of those who resort to the so-called mineral springs which abound in the country. It is not necessary that these springs should hold abnormal quantities of salts of any kind to effect cures; it is only necessary that the water should be pure. Ordinary springs, such as are found in every farmer's pasture, are curative springs if the waters are used freely by those who suffer from certain gastric or renal difficulties." This writer asserts that the best known of our Eastern mineral waters shows, on analysis, that its curative value consists solely in its purity.

It may be truthfully asserted that it is impossible to procure perfectly pure water. "Even distilled water and fresh rain-water contain some ammonia, carbonic acid, and other matters which detract from their purity; while the best water from rivers, wells, ponds, and tanks, contains a large number of chemical compounds, chiefly salts." The skillful use of the microscope would condemn the water from many sources for drinking purposes which now is considered pure. But while we can not obtain strictly pure water, even by distillation, we can obtain it so pure that it will meet our demands, and that without danger to the consumer's health. The means by which this may be accomplished is filtration.

A filter is an apparatus for separating from fluids the foreign substances mechanically intermixed with them and held in suspension. While this is all that most filters aim to accomplish, yet experiments show that a filtering material may be used which very markedly diminishes the foreign bodies usually held in solution in water, and also removes those held in suspension.

The devices that have been used and are now employed for filtering purposes are very numerous. Tracing their history from the old Hippocratic sleeve, which was a cone-shaped bag of cotton or wool, we find, among others, the following materials: Thick unsized paper; cloth of various texture; sand; asbestus; animal charcoal; vegetable charcoal; felt; porous stones of various kinds; spongy iron; porous earthenware; perforated metallic disks; sponge; carferal, a composition consisting of a mixture of charcoal, iron, and clay; silicated carbon; ground slag, or compounds of two or more of these substances mentioned.

The essentials of a good filter for domestic purposes are—1. Efficiency in removing foreign bodies held in suspension. 2. Chemical power to destroy animal and vegetable impurities in solution or to convert them into innocuous substances. 3. Freedom from all possibility of tainting the water. 4. Simplicity of construction, so as to admit of the filtering material being readily renewed. 5. Cheapness. A good filter for domestic purposes must possess all five of these qualities. Those that have two or three of them and lack the remainder do not practically solve the problem of giving us clean water to drink.

The Japanese use a porous sandstone hollowed in the shape of an egg, through which the water percolates into a receptacle underneath; the Egyptians resort to a similar device; the Spaniards use a porous earthen pot. But these and other similar contrivances can not be thoroughly cleansed; after the most thorough rinsing, some impurities will remain in the pores of the stone. Spongy iron and carferal are open to the same objection; they will answer well for a short time, but soon become contaminated by pollution retained in their pores. Sponge, cloth, and felt, unless cleaned every day or two with hot water, will do more harm than good, and the average servant-girl will not clean them or any other filter unless under the eye of her mistress.

The various forms of filters that are screwed to the faucet have only to be hastily examined to be discarded, as there is not sufficient filtering material in them to be of much utility, and they very soon become foul and offensive. Buck says, "There is no material known which can be introduced into the small space of a tap-filter and accomplish any real purification of the water which passes through at the ordinary rate of flow."

The various complicated closed filters, filled with any material which can not be removed for cleansing, condemn themselves. No amount of pumping water through them at different angles, which is at all likely to be used, can cleanse them of the impurities that adhere to the mass and in the pores of the filtering material used. Parkes, in his "Manual of Practical Hygiene," says, "Filters, where the material is cemented up and can not be removed, ought to be abandoned altogether."

The various metal filters in which the water comes in contact with metallic surfaces, either iron, lead, tinned iron, or zinc, are objectionable from their appreciable influence upon the water retained in them for any considerable time. Pure block-tin is the least objectionable of any of the metals.

The aim of most filters is to remove impurities from the water speedily—as rapidly as it escapes from the faucet. Experiment shows that effective filtration can not be accomplished in this way, as the water does not remain long enough in contact with the filtering material used to become purified of much that might be removed by slow filtration or percolation through the same appliance. Of all the filtering materials mentioned, it seems to me that sand and charcoal are the two that accomplish the best results, and of these vegetable charcoal is the best.

Clean quartz sand will retard the passage of some impurities held in suspension, but no very careful investigation is necessary to demonstrate the presence of many impurities in water that has passed through it. The naked eye can detect them in most samples. Buck states, "The spores of algæ are not removed by the passage of water through sand," and he adds that "clean quartz sand can produce little effect" on polluted water. But he and many if not all other sanitarians assert that charcoal does purify the water and remove the odor of putrefaction. While there is no lack of authority to prove the value of animal charcoal as a filtering material, the claims of vegetable charcoal seem to me to make it more serviceable. Vegetable charcoal is "the solid residuum of the destructive distillation of wood." It is insipid and inodorous, it is insoluble in water, it is but little affected by either acids or alkalies. The ash consists chiefly of carbonate of potash, silica, lime, and the oxide of iron. Vegetable charcoal has a strong deodorizing power. Water containing sulphureted hydrogen speedily loses its odor when filtered through it. The taste of liquids, when dependent on the presence of certain organic substances, is almost or entirely removed by filtering through it. "The purifying, antiseptic power of charcoal is due to the action of its absorbed oxygen upon organic matter." A careful authority says: "Charcoal, by possessing the properties of absorption, decomposition, and combination, is eminently fitted as a filter for the purification of water, removing from it the color, odor and taste of its impurities by oxidizing and recombining them into other and inoffensive substances." A reference to chemistry shows us that the following gases are absorbed by charcoal: Hydrogen, nitrogen, carbonic oxide, marsh-gas, nitrous oxide, carbonic acid, olefiant gas, sulphurous acid, air, sulphureted hydrogen, muriatic acid, hydrochloric acid, and ammonia.

Witthaus, in his "General Medical Chemistry," says on this subject: "Its" [vegetable charcoal's] "power of absorbing odorous bodies renders it valuable as a disinfecting and filtering agent, and in the prevention of putrefaction and fermentation of certain liquids. It is with this view that the interiors of barrels intended to hold wine, beer, or water, are carbonized. Certain odorous culinary operations are rendered inodorous by the introduction of a fragment of charcoal into the pot. The efficacy of charcoal as a filtering material is due in a great measure to the oxidizing action of the oxygen contained in its pores."

In the article on vegetable charcoal in the "National Dispensatory," the writer says: "The most fetid gases disengaged by putrefaction are among those which are the most abundantly absorbed by charcoal, viz., ammonia, sulphureted hydrogen, and sulphurous acid, and the oxygen contained in the charcoal combines with the other deleterious substances and generates new and inodorous compounds." Buck says, "All varieties of carbon formed by the destructive distillation of vegetable or animal matter possess the property of removing organic matter from solution." Fowne's "Chemistry" says of charcoal, "It is said to absorb ninety times its volume of ammonical gas." But sufficient authorities have been quoted to prove the high estimate in which vegetable charcoal is held as a filtering material by chemists and sanitarians. Careful experimenting with it has satisfied me of its efficacy and practicability. It is efficient, clean, easily obtained by any one, and so cheap that after a few weeks' use it can be thrown away, and a clean supply substituted, and the cost need not be taken into consideration. Animal charcoal possesses valuable filtering properties, but it is very expensive, difficult to be obtained, and is so associated in the minds of the people with dead horses and the bone-yard that a strong prejudice exists against it. I have thus tried to show in this paper—1. That clean drinking-water is essential to health. 2. Some of the well-established results of drinking polluted water. 3. The various filtering materials that have been used, with their merits and objections. 4. The superiority and availability of vegetable charcoal as a filtering material.

In conclusion, in answering the question, "How, then, may we obtain clean drinking-water?" I would answer, by filtering the water slowly through properly adjusted vegetable charcoal placed in an earthen receptacle of some kind so that the water will not come in contact at any stage of its passage through the filter with metal of any kind. Cool the filtered water by placing ice under or around the vessel in which the water is contained, but do not put the ice into the water, or its impurities will be liberated by melting and contaminate it. Acting on these suggestions, I believe clean drinking-water may be obtained in any family, and, with clean water, less sickness.

PHYSIOLOGY *VERSUS* METAPHYSICS.

By WALTER HAYLE WALSHE, M. D.

"The laboratory is the forecourt of the temple of Philosophy; and whoso has not offered sacrifices and undergone purification there, has little chance of admission into the sanctuary."—Huxley, "Life of Hume."

"It was the glory of Hippocrates to have brought Philosophy into Medicine, and Medicine into Philosophy."—Auctor (?).

"Attendre et espérer" (To wait and hope).—Dumas, "Monte Cristo."

FEW physiologists, mixing in general society, can have failed to notice how common it is to hear their psychological brethren (if referred to at all) stigmatized as atheists; and this alike in coteries distinguished for pugnacious religious dogmatism, and in social circles where indifferentism marks the prevailing tone of thought. The acrimony with which the charge is made apparently increases, on the one hand, in the direct ratio of the bigotry or religious fervor, and, on the other, in the inverse ratio of the scientific enlightenment of different speakers. Furthermore, in certain cliques a shrewd suspicion seems to have arisen that, as any whole includes its parts, physiology in general (nay, even medical science at large) is chargeable with the delinquencies of its cerebral department, and is hence condemned by these judges as a representative in its entirety of atheistic proclivity and purpose. An illustration in point may be found in the columns of the leading daily journal, wherein the reviewer of the volumes of Bain, Bastian, and Luys on Mind, Body, and Brain, "need scarcely say that in all three works the physiological (some would say materialistic) aspects of the subject are strongly insisted upon."* No doubt some would say so, and thence at a bound jump to the conclusion (a foregone one with all who use the word "materialist" in an adverse sense) that all these authors are "atheists." In point of fact, the masses are hardly wiser in their estimate of medical belief than two centuries ago, when lay smartness and ignorance combined had fashioned the libelous apothegm, "*Ubi tres medici, ibi duo athei*" † (where three doctors are, there are two atheists).

Now, metaphysical psychologists, though inquiring as boldly from their point of view into the genesis of mind, have contrariwise, with rarest exceptions, escaped and continued to escape this form of social obloquy. Whence comes this diversity of judgment? Are physiologists thus penalized because they have shown that a certain definite, if subordinate, part is played by physics and chemistry in the complex act of evolving thought, and because they have thus, at least partially, succeeded in wrenching this branch of philosophy from the nerveless grasp of the pure introspectionist? Has the success of cerebral physi-

* The "Times," January 19, 1883.

† Browne, "Religio Medici."

ology in the surface-penetration of some of the secrets of thought-production led to its condemnation? Should those secrets, in obedience to theological casuistry, be allowed to linger on in primitive obscurity, as though the earnest use of our divinest gift, intellect, were not the most fitting and the most grateful form of homage to the all-bounteous Giver? If our science toils on in humble but trusting hope to fathom on material lines the mechanism of our mental operations, is its pursuit antagonistic to belief in an Almighty First Cause?* Is there really any fair ground for the inference, that because physiology strives to trace out and interpret the conditions of the connection between brain-substance and mind—*ergo*, those who labor in its field are of necessity atheists? The inquiries seem to deserve an answer. Let us, then, see to what the teachings of physiology in this direction really amount. Let us try to determine whether (conflicting though they may prove with the postulates of various narrow and sectarian systems of theology) those teachings really antagonize any formal or essential principle of deistic faith, whether, though confessedly open to the charge of "heresy" (that charge so dear to sacerdotalism),† they do not escape even the suspicion of that treason against nature, atheism?‡

We must prelude the inquiry into the direct work of physiology by a very rapid glance at the notions advanced by metaphysicians and theologians on the nature of mind and generation of thought. Our task throughout will be merely one of historical and very occasionally critical review. We lay no claim to originality of doctrine, but shall merely attempt in simple fashion to popularize knowledge, which, alike from its nature and from the manner of its handling, has been essentially limited to the few.

1. Now, metaphysicians (they who profess their ability to formulate an *a priori* theory of the ultimate elements of knowledge and nature of things) have held, as a class, that the act of thinking is in

* Blaise Pascal (1623–'62), philosopher of no mean grasp and honesty though he was, strove to dissuade his generation from following out the Copernican system to its issues because it maintained the heretical doctrine of the movement of the earth. Pascal would not have merited censure for hesitating to accept the Copernican system had he argued on supposed philosophic grounds (Milton died uncertain which to accept, the doctrine of Ptolemy or Copernicus); his grave error consists in having preferred theological *dogma* to that which he felt to be *truth*.

† "Heresy," aptly styled by Lanfrey, "Cette éternelle protestation de la liberté de l'esprit humain contre les doctrines infaillibles" (That eternal protest of liberty of the human mind against infallible doctrines). "Histoire Politique des Papes," p. 70: Ed. Charpentier.

‡ Atheist and atheism are words constantly used in total ignorance of their real meaning. An angry religionist, being asked for his definition of the term atheist, unhesitatingly replied, "I call any man an atheist who does not go to my church, or some one like it." Strong in sectarian conviction, but weak in classical attainment, my friend evidently had, like one greater than he, "small Latin and less Greek," and knew as little of etymology as he felt of toleration for any creed but his own. But was he not (setting aside the question of verbal roots) a fair specimen of a large class?

all its stages and all its factors a non-material process. And it does not involve any serious error to maintain that the formula under which this doctrine obtained the widest acceptance by philosophy, while it best satisfied the craving of ordinary people for some insight into the nature of their mental operations, originated with Descartes. And this philosopher's well-known formula assumed : there exists a spiritual, non-extended, indivisible substance, an objective, immortal entity, superadded to and independent of brain, which thinks, feels, and wills —a substance cognizable by self-consciousness alone, and which is in fact the "thinking principle" or proper "soul." Mind thus becomes absolutely and wholly an extra-cerebral product, and the possible offspring of activity on the part of the "soul" alone. The purely hypothetical character of this doctrine, the feeble, in some sense half-hearted, support given it by its originator, its incompatibility with every-day experiences of cerebral disease, and its proving a hopeless puzzle to cultured people, at once endowed with the critical faculty and unbiased by prejudice, all alike failed to shake its supremacy, and for long years it held sway, not as a makeshift, provisional, mere scholastic formula, but as an established primary truth. And all this, though Descartes himself, in the following words, honestly avowed his disbelief in the surety of his own doctrine : "Je confesse," he writes, "que par la seule raison naturelle nous pouvons faire beaucoup de *conjectures* sur l'âme et avoir de flatteuses espérances, *mais non pas aucune assurance*"* (I confess that by natural reason we can make many conjectures about the soul, and have flattering hopes, but no assurance).

Meanwhile, as mind was thus made a product of the soul, the question at once arose by necessary involution, What in turn was the soul? Now, in all probability, no more startling chapter figures in the history of philosophy than that chronicling the varied efforts made at furnishing a sufficing reply to this query. From the days of Plato to our own, metaphysicians seem to have lost themselves in a maze of conjectures, too often, unfortunately, no less dogmatic in tone than vague and unsatisfactory in essence. Yet be their failures, while unflinchingly registered, freely forgiven ; the obscurity of the problem to be solved, coupled with the imperfection of the instrument selected for its solution, has ever proved an obstacle to success, even when that instrument has been handled by the deepest thinkers and most devoted searchers after truth.

Thus, setting aside the *profanum vulgus* of illogical and inaccurate writers, with whom the word is but a word, carrying with it no inkling even of definite signification, we find that with some philosophers

* In explanation of his doubtingness, we must remember Descartes was not merely a metaphysician—he was likewise a physicist of high distinction. The positive tendencies fostered by physical objective study served to counterbalance within certain limits the subjective transcendental activity of his grand intellect.

the soul is a local, with others a universal, existence; by some limited to man, by others conceded to the lower animals; with certain thinkers an essence, with others a substance, with a third group a principle; with some an immaterial essence without form or extension, with others immaterial, yet possessed of these attributes of matter; with the majority a simple, with the minority a compound, existence, and with a small fraction of the latter a tripartite body, of which each division is again subdivided into three; with this sect a something contained in the body, with that a something containing it; with Aristotle an equivalent of "all the functions, sentient and nutritive, of living bodies up to the highest attributes of intellect," the "rational soul" being especially seated in the heart; * with the Neo-Platonists an "image or product of reason," producing in turn the corporeal; with Descartes the "spiritual substance," or "principle" just referred to, provided with a habitat in the pineal gland, a home exchanged by others for the ventricles, the corpora striata, the white substance of the hemispheres, their cortex, the plexus choroides, the dura mater, the heart, and the blood; with Locke a spiritual essence or a material substance—he could not "fixedly determine" which; with certain philosophers a something pre-existent from all time, with others evolved *pari passu* with the organism it inhabits; in the opinion of one group of school-men perishing with the associated body, in that of a second wholly immortal, in that of a third mortal in the main, but in one of its parts immortal. Further, philosophers who maintained each soul was formed specially for its own individual organism, varied in all conceivable ways as to the time and place of union of the two, while the parallel difficulty followed in settling the precise moment of somatic death at which separation of the two must occur.†

The vast majority of these speculators recoiled from the pre-

* Prochaska, "Nervous System," quoted by Bastian, "The Brain as an Organ of Mind," p. 511. On the contrary, according to the shrewder insight of one of the most far-seeing of physiologists, Xavier Bichat, the heart, or its vicinity, holds relationship to the *passions*, the head to *intellectual* phenomena. "L'acteur," he says, "qui ferait une équivoque à cet égard, qui, en parlant de chagrins rapporterait les gestes à la tête, ou les concentrerait sur le cœur pour annoncer un effort de génie se couvrirait d'un ridicule, que nous sentirions mieux encore que nous le comprendrions" (The actor who should make a mistake in this matter, who, speaking of his griefs, should refer his gestures to his head, and who should concentrate them upon his heart in announcing an intellectual effort, would cover himself with a ridicule that we can feel better than we can comprehend).—"Vie et Mort," p. 42, Paris, 1813.

† Singularly enough, this speculative difficulty has occasionally proved the source of specific practical inconvenience. Thus "Turkish graves are very shallow, sometimes not more than a foot in depth, the reason for this being that most old-fashioned Turks still retain the superstition that the soul does not leave the body until some time after burial, when it is drawn from the grave by the angel of death, who would find great difficulty in performing his task if the body was too deeply buried. The consequence of this is that in warm weather a horrible stench arises from the cemeteries."—"God's Acre Beautiful," by W. Robinson, F. L. S, p. 117.

sumptuous task of attempting to define the actual composition of the soul, a few only of the most wildly transcendental satisfying themselves that it consisted of "a drop of ether," of a "globule or spark of heat or light," of an "animated vapor," etc.

Not more widely divergent than the metaphysical notions of the nature of soul were the doctrines held as to the manner of intercourse between the soul and the body, the school of Aristotle holding that all objects enter into the soul by influx through the senses; the Cartesians, *per contra*, maintaining that it is the soul that sees and hears, that perception is a primary faculty, not of an organ, but of the soul; while Leibnitz and his followers, denying alike the imagined influx from the body into the soul, and from the soul into the body, maintain the existence of a joint consent and coeval operation of both under the influence of a so-called pre-established harmony.

Passing from the earlier metaphysical speculators to Kant (1724–1804), we find once more in the history of human struggles after truth how much easier it is to destroy than to construct. In the firm analytical grasp of that extraordinary thinker ("the most tremendous disintegrating force of modern times") the past fallacies concerning the nature of the soul had scant chance of mercy—the past short-comings as little of escaping exposure. Ancient philosophic creeds crumbled to dust before him. But did he raise any edifice of practical significance on their ruins? Did he identify the soul? Where are they who can fancy that they are the wiser—that they have made a nearer approach to such identification—by accepting his quasi-mystic reveries on the "ego which exists beneath or rather outside consciousness, . . . a noumenon,* an indescribable something, safely located out of space and time, as such not subject to the mutabilities of these phenomenal spheres, . . . and of whos eontologic existence we are made aware by its phenomenal projections or effects in consciousness." † The first clauses of this definition seem pure assumption, soaring aloft beyond the comprehension of ordinary mortals; the latter (granting the premises of the so-called "noumenon") seems a mystified version of a necessary inference. Even Kant himself admits the total concept to be incapable of scientific proof; and of any other form of alleged proof—the so-called transcendental—what is the practical

* The "noumenon" is an "*intelligible* object—that is, one which, if it is to be cognized at all, must be so in and through the *understanding* without any *sensuous* medium" (Kant's "Prolegomena," translated by Bax, p. lxxxvii). This "Ding an sich," "thing in itself," or "noumenon," is held to be the antithesis of the sensuous phenomenon, but the actual relationship of the two was to Kant himself, has been to his disciples, and will presumably prove to the end of time to his successors, the great stumbling-block in the way of thinking out Kant's whole system.

† Quoted by Graham, "Creed of Science," pp. 153, 154. Kant, again, sometimes uses the phrase "the thinking self," as synonymous with soul; and speaks of the "doctrine of body and the doctrine of soul—the first dealing with *extended*, and the second with *thinking*, Nature."

weight? Such "proof," inasmuch as it transcends experience, can never advance beyond the unreality of subjective formulation, can never attain the reality appertaining to objective demonstration. Nay, Kant admits more than this: he grants nothing can really be proved by metaphysics concerning the attributes, or even the existence, of the soul; while holding that, inasmuch as its reality can not, on the other hand, be disproved, such reality may, for moral purposes, be assumed. So that this sublimest of the world's thinkers is obliged in ultimate analysis to admit that ordinary common-sense may prove as successful in wrestling with the problem as the vastest inborn intellectual potentiality intensified by prolonged culture.

Reaching next the modified or hybrid metaphysical and physiological school of the present day (the former element largely predominant), we find one of its most eminent representatives, Bain, seeming to teach that, whatever it is, the soul has but loose connection with the body. "The body might," he assures us, "have its bodily functions without the soul, and the soul might have its psychical functions in some other connection than our present bodies.* But surely, as indeed this psychologist elsewhere himself admits, mind is a function of the body; therefore it follows implicitly from his propositions that *mind may exist without the soul*, whereas the metaphysical contention denies the possibility of thought without it. Note further that this thinker, with wise discretion, shrinks from any disclosure of his own idea, either by affirmation or negation, of the nature of the soul, and leaves us in total ignorance of what he desires us to understand, when on his own behalf he employs the word.

We may remark in passing, that Plato thought the soul could exist without a habitat in the human body. Kant, on the other hand, held it to be beyond our powers to make any affirmation as to the possibility of its separate existence. Dugald Stewart, somewhat in the same vein, held that we "have no direct evidence of the possibility of the thinking and sentient principle exercising its various powers in a separate state from the body." Here, be it observed, the soul, as with Descartes, is a "principle." Is this anything more than a mere *word?* What is the actual *meaning* of the term in this connection? or has it any meaning? What explanation does it furnish of the facts?

The foregoing brief analysis of metaphysical opinion, though obviously and necessarily imperfect, is not one-sided or dishonest, and seems to render the conclusion inevitable that introspective psychology has failed to supply a definite presentment of the nature of soul. Metaphysicians have, in truth, merely postulated its existence and endowed their creation with a series of attributes, the nexus of no single one of which with its assumed factor has ever been made the subject of serious proof; while, in speaking of mind as one manifestation of its activity, they simply ascribe the performance of a positive act (that of

* "Mind and Body," p. 153.

thinking), the mechanism of which they in no wise understand, to an agent (the soul), the mere existence of which they fail to substantiate.

If it be urged on behalf of any class of metaphysical school-men, who may refuse to accept Kant's modest avowal of failure, that they really have succeeded (because to their own contentment) in fathoming the problems of the genesis of mind and the nature of the soul, and that they are not answerable for the defective intelligence of the outside world, which fails to follow them, the physiologist need not hesitate to concede that they soar in a region of visionary transcendentalism, for which his mental bias and material modes of thought have not fitted him either as a worker or a critic. He is as ill adapted for reveling in trains of speculative abstraction, whereof the issue, purely subjective, can never reach the reality of objective demonstrativeness, as the metaphysician for peering through lenses many a weary day and night to verify a single fact, the present obvious value of which may be *nil*, but of which the future story may be written as the starting link of chains of important truths. Between the metaphysical contemplative mind and the scientific observant mind the antagonism is so profound that the union of the two qualities in the same individual, even in very different degrees of potentiality, is the rarest of intellectual endowments.

The physiologist of the pure observation school may, then, admit his deficiency in critical training for the just estimation of metaphysical methods, and this all the more resignedly in that (as we shall by-and-by fully see) metaphysicians are found occasionally confessing, nay boasting, that they fail to understand each other, while they are likewise accused, apparently on justifiable grounds, of not at all times and seasons thoroughly comprehending each man his own individual work. So the physiologist need not trouble himself about methods but ask for results. And this he has ventured to do, conceiving himself entitled by the worth of the latter to gauge the efficiency of the former. While, then, acknowledging in a spirit of homage savoring of of awe the abstract grandeur of the metaphysical intellect and the aims of its activity, he has earnestly but not irreverently inquired, Do you metaphysicians not deceive yourselves? Are you quite sure you do not take words for ideas? Have you or have you not perpetually confounded figments of the brain with realities? To what increments of true knowledge—the real, substantial knowledge of things—can you lay claim? Have you of late done much more than clothe old thoughts in new phraseology—phraseology of greater precision than that it has supplanted, we may fairly concede? Have you not in sober truth been engaged since the dawn of philosophy—*multum agendi, pauxillum agentes* (doing much, accomplishing little)—in a still beginning, never ending, logomachia? Can you point among your fellows to that emphatic unanimity of creed on fundamental questions which shall demand, as its right, acceptance from the outside world, before which you pose as the fountain-heads of all ultimate knowledge? Or, have you not, on the very contrary, disagreed absolutely with each other? And, if you doubt each other, may *we* not in turn doubt you all? Is it not true that Kant never mastered, and loudly proclaimed he never could master, the doctrine of Spinoza? * Did not the philosopher of Königsberg declare the system of Fichte to be utterly untenable? Does not Schopenhauer in turn repudiate Kant? Were not the leading principles of Schopenhauer's own system contained, and in some measure worked out, in Fichte's "Wissenschaftslehre"? And did not the same Schopenhauer, having failed to perceive the similarity (carping critics have been found malicious enough to more than hint that perhaps he herein judged wisely), stigmatize that work, the alleged germ of his own, as a "farrago of absurdities"? † Has not J. S. Mill declared it to be characteristic of Hamilton that he seldom or never adhered to any philosophic statement he had adopted, that "an almost incredible multitude of inconsistencies show themselves on comparing different passages of his works with each other," and that his whole system of "intuitional" philosophy is a profound mistake? ‡ And is it not equally true that the adherents of the Scotch philosopher seem to have made it plain that his somewhat ruthless English critic never succeeded in understanding him? # Furthermore, has it not been averred by one of his most earnest panegyrists that Kant failed himself to grasp the full import of his own doctrines, that the "new light that was lighted for men" could not illumine his own ideas sufficiently to grasp their total meaning and anticipate the terms of their ultimate evolution? ‖ Finally, has not Berkeley with equal truth and candor pronounced the condemnation alike of his own work and of all his fellow-craftsmen in the fatal admission, "*We metaphysicians have first raised a dust, and then complain we can not see*"? ^

To the non-metaphysical mind it would indeed appear that the bootless speculations of the pure transcendentalist were calculated on the one hand to dishearten wayfarers on the road to truth by blocking the route with unintelligible mysticism, and on the other to postpone the discovery of a share of Nature's secrets by diverting any available mental power into a wrong channel. ◊ How could aught but

* Kant's "Prolegomena," translated by Bax, p. xxxv.

† E. B. Bax, ibid., p. 101.

‡ J. S. Mill, "Autobiography," pp. 275, 276, third edition, 1874.

Maudsley, "Journal of Mental Science," vol. xi, p. 551.

‖ E. B. Bax, ibid., preface, p. 3.

^ "Human Knowledge," vol. i, p. 74.

◊ So far from its being desirable that that rare form of gift or "acquired mental dexterity," as the introspective faculty is affirmed to be by Sir William Hamilton, should be vouchsafed to cultured mankind at large, the endowment may, without probable ultimate loss to real knowledge, be left in the grasp of the limited class for which its possession is claimed.

failure in solving the problems of mental philosophy be expected from a system, even though that system were sustained by surpassing intellectual force, that ignored the instrument, brain, by which the result, mind, is evolved? What success could be expected from an inquiry into the mechanism of respiration, from which all consideration of the structure, dynamics, and chemistry of the breathing-organs was purposely excluded? Conceive a man proceeding to investigate the respiratory process who had never seen a lung! Should we consider him perfectly sane? How ineffably curious, then, if not ludicrous, does it seem to find Bain announcing, with in some sort the tone of a man who has stumbled on a happy discovery, that it would be worth the while of metaphysicians to learn something of nerves—we presume, impliedly, something of brain also! Still this niggard dole of acknowledgment places the donor at all events in advance of J. S. Mill, who to the very close of his career contemptuously and obtrusively rejected cerebral physiology as a guide, of even the most subordinate value, in the study of mind. Why, the solitary discovery of the connection of aphasia with a special spot in a special gyrus of a special hemisphere of the brain, taken in conjunction with the corollaries logically deducible from that connection, seems a far weightier offering toward the elucidation of the actual mechanism of mind—of the conditions under which Nature works—than all the transcendental guesswork furnished by the toil of metaphysicians from Plato to Schopenhauer.

Nevertheless, the conspicuous failure of purely introspective philosophy, unaided by objective investigation, to establish its special psychic doctrines, does not, on the other hand, disprove the possible independent existence of soul as one of the factors of mind. Such existence may be, or may not be, a reality, for anything that metaphysics show or do not show. The failure of transcendentalism, admitted even by Kant, simply proves that in wisdom which is not of pure and unaided metaphysics lies such lingering hope, as an enthusiast may cling to, of substantiating the reality and the nature of the soul's existence and practical activity. Nor does the failure signify (whatever may be its import as to the efficiency of transcendentalism) that introspection must not be allowed to play a large though far from the solitary part in the attempt to elucidate the nature of mental operations. To reject the help of introspection in analyzing the phenomena of mind would be as illogical, nay fatuous, on the part of the physiologist as the negation of the utility of all objective aid by the bulk of metaphysicians. But in point of fact such rejection is a sheer impossibility, for we can not cogitate without examining consciousness, and when we do this we introspect. Besides, there are facts of mental operation, and laws regulating these facts, which lie without the pale of physiology as an objective factor, facts and laws which can only be even guessed at by the analysis of self-consciousness. The results of such analysis plainly can not be claimed by a department of inquiry which deals with phenomena physically demonstrable alone; be those results sound or unsound, conclusive or tentative, final or provisional, such as they are, they are the property of introspective psychology alone. Furthermore, there is a large class of psychological concepts framed on a combination of both kinds of evidence, subjective and objective.

PROFESSOR DVORÁK'S SOUND-MILLS.

PROFESSOR SILVANUS P. THOMPSON has made known, through the columns of "Nature," an interesting series of experiments by Professor V. Dvorák, of the University of Agram, in the production of an apparatus which should rotate under the influence of sound-waves in the same way as the radiometer introduced by Professor Crookes rotates under the influence of rays of light and heat. The same idea was suggested independently to several men, among whom were our countrymen, Professor A. M. Mayer, of Hoboken, and Mr. Edison, all of whom have made in the matter researches of great scientific interest. Professor Dvorák has devised four kinds of "sound-mills," as they may be called, two of which depend on the repulsion of resonant boxes, and two on different principles.

One of the instruments is represented in Fig. 1. It consists of a light wooden cross, balanced on a needle-point, and carrying four light resonators—hollow balls of glass, forty-four millimetres in diameter,

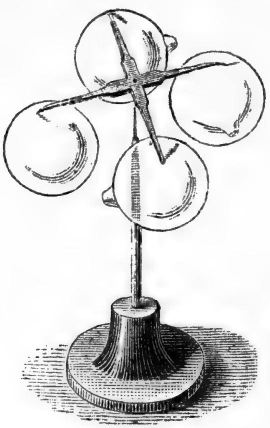

Fig. 1.

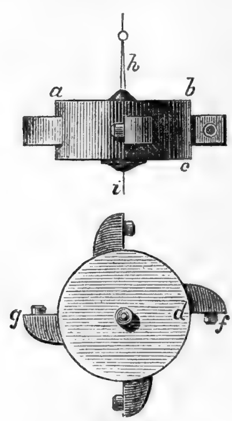

Fig. 2.

with an opening of four millimetres at one side, and responding to the note g', or the middle G, of the piano-forte (= 392 vibrations). When this note is forcibly sounded by the tuning-fork, the air in the resonators vibrates in response, and the apparatus begins to rotate. Rotation will take place even if there is only one resonator, properly balanced; but the phenomenon is more marked and certain if there are four.

A second style of apparatus—the "rotating resonator"—is represented in plan and elevation in Fig. 2. It consists of a short cylindrical box of stiff paper, having four projections, each of which bears at its side a short open tube of paper. It is hung on a silk fiber, and is supplied with a small needle, projecting below to steady the motion during its rotation.

The operation of these instruments depends on the principle which has been pointed out by Lord Rayleigh and Professor Mayer as well as by Professor Dvorák, that "when sounds of great intensity are produced, the calculations, which are usually carried only to the first order of approximation, cease to be adequate, because now the amplitude of motion of the particles in the sound-wave is not infinitely small as compared with the lengths of the sound-waves themselves. Mathematical analysis shows that under these circumstances the wave of the pressures in the condensed part, and in the rarefied part of the sound-wave, is no longer equal to the undisturbed atmospheric pressure, but is always greater. Consequently, at all nodal points in the vibrations of the air in tubes or resonant boxes, the pressure of the air is greater than elsewhere; and therefore any resonator closed at one side and open at the other is urged along bodily by the slight internal excess of pressure on the closed end." The apparatuses therefore rotate by reaction.

To produce vibrations of sufficient intensity, Professor Dvorák uses heavy tuning-forks mounted on resonant cases, and excited electrically. For this purpose he places between the prongs of the fork an electro-magnet, in which the core is composed of two plates of iron, separated by a sheet of paper, and cut of such a breadth as to lie between the prongs without touching them. The core is overwound with insulated copper wire, as shown at E, Fig. 3, and the electro-magnet is mounted by a bent piece of wood, *a b c*, upon the sounding-box, K, of the fork. The wires are connected in a circuit with the battery, and with the electro-magnet of a self-exciting tuning-fork of the same note. The sounding-boxes of the forks must not touch the table, but the arm *a b c* is clipped at about the point *b* in a firm support; and particular care must be taken to have the wood of the resonant boxes tuned into exact accord with the tone of the fork and of the air within the cavity of the box.

The third apparatus is the "sound-radiometer," and was described by Professor Dvorák before the Imperial Viennese Academy in 1881. It is more simple than the two instruments previously described, but its cause of action is less easily explained. It is shown in Fig. 4. It consists of a light cross of wood pivoted by a glass cap upon a vertical needle, and having attached to its four arms four pieces of white card, perforated with holes which are depressed conically on one side and raised at the other, so as to present a surface something like that of a nutmeg-grater. Each card has twenty-five holes thus pierced, and the

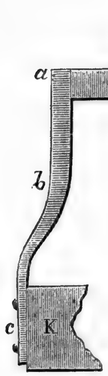

FIG 3.

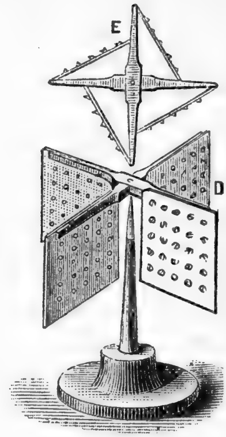

FIG. 4.

whole apparatus a hundred holes. The rotations are more rapid if the cards are set on obliquely in the fashion shown at E in the figures, with the burred sides outward. The rotations are produced when the "mill" is set in front of the resonant box.

Dvorák's fourth apparatus is called by him an "acoustic anemometer," and is represented in Fig. 5. It consists of a little "mill" of simple construction, *h i k*, the vanes of which are made of small pieces of paper or card slightly curved, and a sounding-box, *c d f g*, placed a little way from it, while between them is held an ordinary Helmholtz's

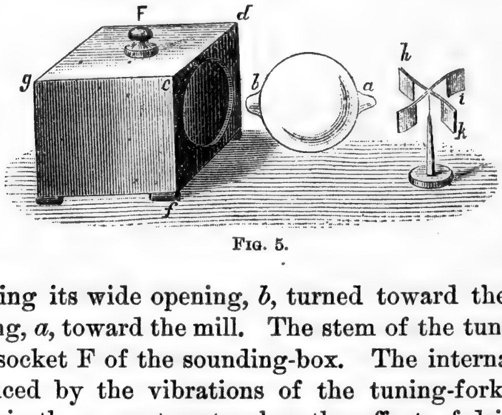

FIG. 5.

resonator having its wide opening, *b*, turned toward the box, and its narrow opening, *a*, toward the mill. The stem of the tuning-fork is inserted in the socket F of the sounding-box. The internal increase of pressure induced by the vibrations of the tuning-fork through the sounding-box in the resonator at *a* has the effect of driving a jet of air gently against the sails of the mill, which consequently rotates. The two-aperture resonator of this apparatus may be replaced by a resonator having but one aperture, which may be formed of a glass ball cut away at one side and cemented to a glass plate having a small hole in the center. When the air ejected from the mouth of the resonator is examined by the method of mixing smoke with it, and then viewing it through slits cut in an open disk, the currents are seen to consist of a series of vortex rings. A variation of this anemometer may be made by taking a card pierced with a hundred holes and placing it between the resonant box and the "mill," when the latter will rotate in the wind which passes through the conical holes.

The machines of Mayer, Mach, and others, are closely akin to those of Professor Dvorák in design and action. Mr. Edison also has contrived a phonometer, or instrument for measuring the mechanical force of sound-waves produced by the human voice, in which the vibrations produced in the phonograph-diaphragm by a sound made in the mouthpiece propels a finely-cut ratchet-wheel with considerable velocity. With this device Mr. Edison has "literally accomplished the feat of talking a hole through a deal board."

ARNOLD HENRY GUYOT.

BY PROFESSOR W. B. SCOTT.

THE political disturbances of 1848, injurious as they were to Switzerland, were directly a great gain to America, for they gave to this country both Agassiz and Guyot, for a long time co-laborers for the advancement of American science and the diffusion of sound learning among the people. "We are led to wonder how much scientific progress would have been delayed in this country if it had not been for the inspiring and co-operating influence of these noble immigrants." *

ARNOLD HENRY GUYOT was born near Neufchâtel, Switzerland, September 8, 1807. His early education was obtained at his native town, and it is interesting to note that during his school-life there he was president of the gymnastic club, and one of the best of the school athletes. His slight, wiry frame thus received a training in strength and endurance which afterward stood him in good stead when he undertook the immense labors of glacier-study in Switzerland and of mountain-surveying in America. On leaving Neufchâtel he went to complete his studies in Germany, attending successively the gymnasia of Stuttgart and Carlsruhe. At Carlsruhe he was an inmate of the family of the Brauns, and there met his countryman Agassiz, who, with Imhoff and Carl Schimper, was making a vacation visit to his friend Alexan-

* "Science," No. 55, p. 220.

der Braun. This period was one of the critical points in Guyot's career. There was formed that close and tender friendship with Agassiz which lasted until the latter's death, and found its final expression in the beautiful memoir of Agassiz which Guyot prepared for the National Academy of Sciences in 1877. But of still greater importance was the impulse toward the study of science which he received from the enthusiastic group of young naturalists with whom he was thus brought into daily and hourly contact. He says of this period: "My remembrances of these few months of alternate work and play, attended by so much real progress, are among the most delightful of my early days. . . . It would be idle to attempt to determine the measure of mutual benefit derived by these young students of Nature from their meeting under such favorable circumstances. It certainly was very great, and we need no other proof of the strong impulse they all received from it than the new ardor with which each pursued and subsequently performed his life-work."

In 1829 young Guyot went to Berlin in order to complete the theological studies which he had begun at Neufchâtel; but the love of science was strong within him, and the new field which the lectures of Steffens, Hegel, and Ritter opened up to his view decided him to enter upon the study of Nature as his life-work. Having thus decided, he determined to lay his foundations broad and deep, and with this end in view he attended lectures on nearly all departments of natural science: chemistry, physics, meteorology, zoölogy, geology, and physical geography, alike received attention, and his subsequent career showed the great wisdom of this thorough preparation. In 1835 he received the degree of Doctor of Philosophy, and at once proceeded to Paris. Here he resided more than four years, quietly pursuing his preparatory studies and extending them in vacation by tours of observation through various European countries. He also took up the subject of history under Michelet, and, like everything else which he touched, made it valuable in the great pursuit of his life, the study of earth and man.

In the spring of 1838 Agassiz came to Paris, enthusiastic upon the subject of glaciers, and this induced Guyot to turn his attention in the same direction. In the summer of the same year he went to Switzerland and began his work on the glaciers of that country. The results of the summer's work were presented in a paper before the Geological Society of France during the session of 1838, at Porrentuy. This paper is mentioned in the "Proceedings" of the society ("Bulletin," vol. ix, p. 407), but, owing to a long illness of the author during the following winter, it could not be printed. The great laws of glacial phenomena first enunciated by Guyot in this paper were afterward announced as new discoveries by other observers, and were the occasion of bitter quarrels. Afterward, when a discussion arose between Forbes and Agassiz, the manuscript was, on motion of Agassiz, and by a formal vote, deposited as a voucher with the Society of Natural Sciences at Neufchâtel, and was printed by that society in 1883. This paper contained the following contributions to the subject: 1. The sloping of the terminal beds of glaciers toward their interior, and their origin as closed-up crevasses. 2. The laminated structure or blue bands of glacier-ice. 3. The cause of the fan-shaped disposition of crevasses. 4. The more rapid motion of the glacier's center than of the sides. 5. The more rapid motion of the top than the bottom of the glacier. 6. The movement of glaciers which takes place by means of a molecular displacement, whence results the plasticity of the glacier. Later, he added the law of the formation of transverse crevasses in a plane perpendicular to the steepest slope of the glacier. With rare modesty Guyot never took part in the fierce discussions caused by the claim laid by others to his own discoveries, contenting himself with a simple statement of the facts published long afterward in his memoir on Agassiz.

In 1839 Guyot accepted a call to the Academy of Neufchâtel, where his friend Agassiz was then settled, and there he remained till his removal to America in 1848. His chair was that of History and Physical Geography, and he regarded the years of his work there as the period of his greatest intellectual activity. During this time he gave much attention to his glacial work, taking up the geological side of the question, the erratic blocks and ancient extension of the glaciers, and devoting to this work "absolutely single-handed, seven laborious summers, from 1840 to 1847." This gigantic undertaking was brought to a successful conclusion, though the results were but partially published, inasmuch as the "Système Glaciaire," by Agassiz, Guyot, and Desor, never went further than the first volume (Paris, 1847). Guyot's collection of five thousand erratic rocks, illustrating eleven erratic basins, now fills a room in the Princeton Museum, a monument of incredibly pains-taking labor.

The political disturbances of 1848 induced Guyot to follow his friend Agassiz to America, and he lived for some time at Cambridge, Massachusetts. He first attracted public attention by the remarkable series of lectures afterward published in the well-known book "Earth and Man." These lectures were the starting-point of a great reform in the historical and geographical teaching of this country. For six years he was engaged by the Board of Education of Massachusetts as a lecturer to the normal schools on geography and the methods of teaching it, and after he came to Princeton he followed up the work there commenced by preparing a series of geographical text-books and large maps. To use the words of a recent writer in "Science" with regard to these books: "It is not too much to say that they revolutionized the methods of teaching geography. Every series of geographies which has since appeared shows the influence of Guyot." He threw aside the old routine methods, and brought the pupil face to face with Nature, showing the bearing of the earth's physical features upon every department of human interest.

Another pre-eminent service which Guyot rendered to America was the work he did in meteorology, a science which had received very little attention when he arrived in this country. From 1851 to 1859 he worked at the preparation of the "Meteorological and Physical Tables," published by the Smithsonian Institution, and also superintended the construction of accurate meteorological instruments. In connection with Professor Henry he must be regarded as the founder of the system of weather observations and reports which has resulted in the Government Signal Service.

In 1854 Guyot was elected to the chair of Geology and Physical Geography at Princeton, a post which he filled for the thirty remaining years of his life. Until compelled to cease by the increasing infirmities of age, he devoted all his vacations and spare time to his favorite investigations, making elaborate and careful examinations of the mountains from New England to South Carolina. This work involved an immense amount of hardship and fatigue, and he was fond of describing with quaint picturesqueness and humor his experiences in roughing it in the mountains of Pennsylvania and the Carolinas. In 1861 he published in the "American Journal of Science and Arts" the results of his work up to that time, "a memoir which remains to this day the best existing description." Again, in 1880, he brought out another memoir on the same subject, devoted chiefly to the Catskills, some of the rough work for which was done after he was seventy years old. Many shorter papers on meteorological, physical, and geographical subjects were written at intervals, but no complete list of them has ever been prepared. His work during this period is a noble example of what may be done without appropriations or endowments, for in those days Princeton was very poor, and he had to do as best he could without assistance.

As a friend and teacher Guyot will ever be held in loving remembrance till the last of his hundreds of students shall have followed him to the grave. His lectures were wonderfully fascinating, leading his hearers step by step to heights whence they could survey the whole field. His broad culture, gained by the combination of the humanitarian and scientific studies, had given him an extraordinary power of generalization, stimulating his students by showing them the relations of any subject which he handled to the whole realm of knowledge. He was able to depict these sciences in their true perspective without distortion or exaggeration, a power which is unhappily very uncommon. Those who had the rare privilege of pursuing advanced courses of study under his supervision will long remember the great stimulus to earnest work which they received from him, and the clear, philosophical views of Nature which he expounded.

For many years Guyot labored under great disadvantages from the lack of proper appliances, but he never allowed these drawbacks to lower the character of his work. When Princeton's day of prosperity came, he showed that he knew how to apply money wisely, as before he had been able to do grand work without it. The system of scientific expeditions to the West, which has so greatly stimulated the study of natural science at Princeton, and added so greatly to the treasures of her museums, was organized under his direction; and the wonderful growth of all the departments of natural science in the college must be in very large measure attributed to the wisdom and foresight of Guyot.

The visible monument of Guyot's work in Princeton will always be the Museum of Geology and Archæology. He expended with consummate skill the sums placed at his disposal by generous friends, and organized an enthusiastic corps of workers, so that a superb series of collections has been gathered. Thus in every department of activity his influence has been of the utmost service to Princeton in particular, and to American science in general.

But even this brief and imperfect sketch can not close without some testimony to his noble and exalted character, modest, unselfish, and devoted. "He never seemed to be thinking of himself, but always of his subject and his hearers. He cared very little for fame, very much for the study of Nature and the education of man." * An earnest and consistent Christian throughout his life, he was ever charitable and tender, never indulging in acrimonious criticism or denunciation of those who differed even most widely from him. Always liberal, he sympathized with and appreciated honest opinion on whatever side it was uttered. He was remarkable for "the beauty in his daily life as well as for his nobly finished work." There is little cause for grief in the quiet close of such a splendid, useful, and complete career as this; nevertheless, we must mourn our irreparable loss, sorrowing most of all that we shall see his face no more.

* "Science," *loc. cit.*

EDITOR'S TABLE.

THE PROGRESS OF MENTAL SCIENCE.

It is gratifying to remark the steady and assured advance of psychological research on the objective or corporeal side, or what is now better known as mental physiology. Without denying the validity of the old method of studying the mind by introspective observation, or that there are regularities and uniformities in the changes of consciousness thus revealed which are the proper subject-matter of science, it is still true that this method does not reach down to the conditions which give law to mental operations, and can not deal with the most fundamental questions of psychical science. It is the organic side of mind which determines mental phenomena, and the science of mind is, therefore, radically incomplete until the nervous system is made the basis of exploration in its manifestation of psychical effects. It can hardly be said that there was anything entitled to recognition, as a proper science of mind, until the bodily conditions and concomitants of feeling and thought became an essential part of the study, and, when that was done, the progress of knowledge upon the subject was clear, decisive, and in the highest degree important. To appreciate the latest phase of this interesting research, it will be desirable to recall some of the signal steps of advancement which have been made in recent years in this line of investigation.

Throughout past ages, from the ancient classical period onward, although philosophy was ever busy with questions concerning the nature and powers of the soul, nobody dreamed that it had a fixed and definite working relation to the universe through the living mechanism with which it was associated. The anatomy and physiology of the last century, however, prepared the way for the successful elucidation of the subject, and the first great step forward was made by Sir Charles Bell about the year 1825, in establishing the double action of the nervous system, or that impressions from the external world pour in upon the brain through one set of nerve-lines, while all the mandates of volition controlling human activity are transmitted outward along another system of nerve-lines. This was a triumph of anatomy and experimental physiology, and a very striking fact, yet the profound significance of the discovery could not be at all appreciated at the time, as it derived its chief importance from the train of disclosures that grew out of it.

It was at first supposed that all peripheral impressions are sent directly to the brain or sensorium, and that all commands of the will are also transmitted uninterruptedly from the brain to the muscles. But about 1840 Dr. Marshall Hall made another capital step of progress by establishing the reflex function of the spinal cord, or by showing that the spinal centers have a control of muscular movements and organic processes independent of the brain. The element of automatism in the working of the living machinery was here brought out, and it was discovered that there are self-working systems in the living economy, by which important gradations of effect are secured. The lower and simpler centers of the spinal system control the fundamental processes of organic life, involving the action of the heart, and the respiratory and digestive apparatus. It is as if these could not be intrusted to the higher organ of volition, which, becoming exhausted, sinks daily into inaction and unconsciousness, but must be committed to specific centers which act with automatic certainty and never sleep.

Pursuing this line of inquiry, a third important step was taken by establishing the separate and automatic functions of the sensory ganglia at the base of the brain and the summit of the spinal column. Impressions from the surface reaching the spinal centers are passed upward to the sensory ganglia, and there give rise to sensations and emerge into consciousness, reflex action being here extended to conscious movements. Dr. Carpenter did much to unravel this branch of the subject about 1850, and his work on "Mental Physiology," published within a few years, will be found full of interesting and important information in relation to it. The problems entered upon were, of course, of great complexity, obscurity, and difficulty. Dr. Laycock had carried the doctrine of reflex action into the cerebral hemispheres, and shown its importance in the higher operations of the mind; and it yet remains a sharply debated question among nervous physiologists how far the principle of automatism extends in the higher realm of our psychical life.

It was thus gradually established that all mental operations, all thought, feeling, instinct, and volition, are the results, first, of the activity of the primary nervous elements, cells, and fibers, by which nervous influence is accumulated and discharged; and, second, of the interaction of numerous automatic centers variously endowed, but communicating with each other solely by the transmission of nervous force. The gain thus secured to mental science on its practical and progressive side was very great. The subject took its place among the definite and experimental science of the natural world. Nothing is so vague as the conception of mind from the metaphysical point of view. Quantitative results are unattainable by that method, and all limitations are scorned by it as degrading to the dignity of spiritual being. But in inquiring into the functions of the nervous system we are at once deeply involved in the physiology of limitations. Mind-force can not come from nothing, any more than other forms of force, and here as elsewhere one effect is at the expense of another. Thinking and feeling exhaust the mechanism, and we are involved with practical questions of waste and repair, exercise and rest, food, blood, nutrition, and the hereditary qualities of the nerve-centers.

Here also the study of mind widens out into the comprehensiveness of a true science by including all the grades of animal life as objects of psychological study. For here as well as everywhere else the higher is to be interpreted by the lower, the complex by the simple, and no animate creature is so far down in the scale that it does not illustrate some phase of mind which has a bearing upon the mental problems of higher beings. The introspective method of course breaks down here. Confined to the adult mind, it excludes the minds of children, and therefore the study of the laws of mental growth; confined to the human mind, it excludes those of all inferior beings. Yet when it becomes a question of determining the properties of nerve-centers, the nature of reflex action, of instinctive movements, and all forms of the laws of intelligence, then comparative psychology makes invaluable contributions to mental science.

And there is still another division of the study of mind of supreme importance, to which very little was or could be contributed by the old method, but which is making marked progress by the more recent methods of investigation: we refer to the subject of insanity. When we come to mental derangements, introversive study is obviously fruitless, and so long as that was pursued nothing was known of the nature of insanity. Mental disease in its basis and causation is bodily disease, and the multitudinous forms of mental weakness, degeneracy, and aberration are to be studied as effects of corporeal infirmity or disease of the nerve-structure. The light thrown upon the science of mind through the manifestations of mental failure has been of great importance, and physiological investigation has now brought us to another and very significant aspect of the subject.

For all scientific men the doctrine of evolution is established, and its highest interest to them is that it is constantly giving new clews to the interpretation of nature and opening new avenues to productive research. This doctrine teaches that the grades of life have arisen in past ages through the operation of laws by which the higher have been derived from the lower. But if this be true, then the nervous systems of animated beings are to be regarded as products of evolution, so that the hierarchy of nervous centers of which we have spoken has been built up by the successive attainment of higher and higher levels of organization. Man, as the latest product and highest term of evolution, combines in his organism the various automatic systems successively reached in the long course of organic development. Biology works out the great laws of upward and divergent unfolding, but there is another side to the phenomena which it is the business of pathology to investigate. Corresponding to the progressive and upward changes of evolution, there are the downward and retrogressive changes of dissolution, by which the constructive work is reversed and undone. But, if we have a true theory of the way the nervous system of man has been evolved, will not that theory afford guidance concerning the order of dissolution, and throw light upon the nature of nervous maladies and mental derangement? This question has been answered affirmatively. We print a lecture by Dr. J. Hughlings Jackson, the first of a course before the Royal College of Physicians in London, on the "Evolution and Dissolution of the Nervous System," in which the subject is treated from the point of view here indicated. Dr. Hughlings Jackson is not only an eminent practitioner in the department of nervous diseases, but he is an able philosophical student of medical subjects, and, although the Croonian lectures are addressed to medical men, the one we print will be found of general interest as opening a new chapter of original investigation in this important field of research.

A MODEL BENEFACTION.

It is announced in the papers that Mr. Andrew Carnegie has given the sum of fifty thousand dollars to the Bellevue Hospital Medical College of this city, for the erection and equipment of a building to be devoted to original investigations on subjects connected with the progress of medicine and the prevention of disease. Mr. Carnegie is well known as a man of large liberality who has accumualted a fortune by his own enterprise, and uses it generously in the promotion of projects of public and private beneficence. We have before had occasion to observe the wise discrimination of his contributions, but in this case he has undoubtedly devoted his money to the noblest use for which money can ever be expended. The endowment of hospitals and dispensaries for the immediate relief of suffering is, of course, highly commendable, and they are so obviously necessary, and their benign results are so direct and palpable, that sympathetic charity is ever ready to lend them support. But that is a more far-sighted and efficient benevolence which provides for the extension of medical knowledge, the research into the causes and conditions of disease, and the increase in the resources of medical art, by the systematic scientific investigation to which we owe all the progress that has yet been achieved in this important field. There has never been a time in the history of medicine when the need of independent original research was so great as now, when the questions demanding elucidation were so numerous and so grave, and the encouragements to their pursuit so promising. The sciences of observation and experiment have done much for the world in many ways, and the medical art has fully shared in the advantages they have conferred; but work in this direction is modern, and that which has been accomplished is as nothing to what yet remains to be done. It is well for the medical colleges to teach what is known, but they need to know a great deal more, and it is certainly high time that we should have a class of professional investigators in this country so thoroughly qualified and prepared for their work that our students will not have to go to Europe after the facilities for profound and exhaustive research. Mr. Carnegie's gift, by establishing an ample and well-appointed laboratory for the experimental study of important medical subjects, will favor the progress of American science, at the same time that it promotes those interests of humanity that are wider than nationalities. The questions to be taken up in such an institution and that are now in most urgent need of solution are many, and one of them was so well stated by a writer in a morning paper that we quote it:

Histological investigations — that is, by means of the microscope—have within late years shed much light on the heretofore occult processes taking place in the different parts of the body in health and disease, and, quite recently, scientific developments in this field of study have shown the vast importance of these investigations, together with experimental researches, as regards our knowledge of micro-organisms. Already it has been demonstrated that several of the infectious diseases are caused by specific parasitic bacteria, and it is more than probable that investigations now in progress will lead to further discoveries rendering preventable and controllable many diseases which occasion much human suffering and contribute largely to mortality. It is, perhaps, not extravagant to say that the discoveries already made, conjoined with those which are foreshadowed, will prove of greater importance in their influence on the science and practice of medicine than any since the great discovery of the circulation of the blood by Harvey.

LITERARY NOTICES.

A Treatise on Insanity in its Medical Relations. By William A. Hammond, M. D. New York: D. Appleton & Co. Pp. 767. Price, $5.

Whether insanity is on the increase throughout the civilized world, as is claimed by many and is certainly not improbable, or whether the apparent increase is due to increasing knowledge in regard to its real extent, the growing interest and importance of the subject are not to be questioned. It is impossible that science should not have made great advances in the elucidation of this most complex subject, depending as it does upon the progress of physiology, psychology, pathology, and therapeutics, and cultivated by specialists as an independent branch of practical medicine; while through the whole historic period down to quite recent times the ignorance, prejudice, and barbarism that have been displayed by society toward the most unfortunate of our fellow-creatures have been one of the darkest chapters of human experience; on the other hand, the spirit of investigation can offer no triumph so great as that which has been achieved by the medical profession in dispelling old prejudices and illusions, and giving a rational account of the conditions, causes, and diversities of mental alienation. The subject is, indeed, yet full of obscurity, and far enough from having been cleared up, but great steps forward have been taken, and in no field is there more continued activity of research. Dr. Hammond's comprehensive and able work is a contribution to the subject made in the light of the latest achievements in all its dependent branches of inquiry. We have looked through his treatise with much interest and constant instruction, and have already given in the "Monthly" some important passages from it as it was going through the press. We have been struck by one feature of the treatise, which indicates an important advance, and which involves the author's fundamental view of the subject. He draws a line between legal and medical insanity, and shows that the latter conception is far wider, taking into account slight mental failures which legislation can not recognize. His work is not on the medical jurisprudence of insanity, which deals with the subject entirely on the legal side, but it is a scientific inquiry into all grades and forms of mental aberration, and deals with the subject with reference to the treatment of mental disease rather than the responsibilities of the alienist class. We quote the author's statement in his preface of these views by which he has been guided in the preparation of the work:

> I have long been convinced that the term "insanity" has hitherto been applied in altogether too limited and illogical a manner. It has been understood, both in and out of the profession, that a person, in order to be considered the subject of mental aberration, must, at some time or other, present certain marked symptoms, which he can not avoid exhibiting, and which are sufficient to indicate to the world that he is not in his right mind.
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> Starting from the points that all normal mental phenomena are the result of the action of a healthy brain, and that all abnormal manifestations of mind are the result of the functionation of a diseased or deranged brain, I do not see why these latter should not be included under the designation of "insanity," as much as the former are embraced under the term "sanity." There can be no middle ground, for the brain is either in a healthy or an unhealthy condition. If healthy, the product of its action is "sanity"; if unhealthy, "insanity."
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> Of course very little of such insanity comes under the signification given to the word by lawyers and the public generally. But legal insanity and medical insanity are very different things, and the two standards can never and ought never to be the same. The law establishes an arbitrary and unscientific line, and declares that every act performed on one side of this line is the act of a sane mind, while all acts done on the other side result from insane minds. This line may be in one place to-day, and in an entirely different place to-morrow, at the whim or caprice of a Legislature; it may be established on a certain parallel in one country, and on an entirely different parallel in another country. In the State of New York, for instance, it is drawn at the knowledge of right and wrong; and perhaps, all things considered, this is about as correct a legal line as a due regard for the safety of society will permit to be made. But every physician knows that it is absolutely untenable from his point of view; that it is not a medical line, and that there are thousands of lunatics insane enough to believe themselves to be veritable Julius Cæsars, and yet sufficiently sane to know that a particular act is contrary to law, and to be fully aware of the nature and consequences of such act. Hence it follows that, from a medical stand-point, there is no middle ground between sanity and insanity. The line of demarkation is sharply drawn, and it is but a step from one territory to the other. There is a large proportion of the population of every civilized community composed of individuals whose insanity is known only to themselves, and perhaps to some of those who are in intimate social relations with them, who have lost none of their rights, privileges, or responsibilities as citizens, who transact their business with fidelity and accuracy, and yet who are as truly insane, though in a less degree, as the most furious maniac who dashes his head against the stone-walls of his cell. To many of these persons life is a burden they would willingly throw off, death concerned them alone, for they are painfully conscious of their actual suffering, and morbidly apprehensive in regard to the future. There are very few people who have not, at some time or other, perhaps for a moment only, been medically insane. It is time, therefore, that the horror of the word should be dissipated, and that the fact should be recognized and acted upon, that a disordered mind is just as surely the result of a disordered brain as dyspepsia is of a deranged stomach; that a scarcely appreciable increase or diminution of the blood-supply to the brain will lead as surely to mental derangement of some kind as an apparently insignificant change of the muscular tissue of the heart to fat will lead to a derangement of the circulation, and that in the one case there may be a hallucination, a delusion, a morbid impulse, or a paralysis of the will, just as in the other there may be an intermittent pulse, a vertigo, or a fainting-fit. There is no more disgrace to be attached to the one condition than to the other.

An Examination of the Philosophy of the Unknowable as expounded by Herbert Spencer. By William M. Lacy. Philadelphia: Benjamin F. Lacy. Pp. 235.

This volume is a metaphysical onslaught on Herbert Spencer's metaphysics, and may be recommended to all interested in the subject as acute, subtile, ingenious, and very well stated. A writer in "Science," reviewing the book, declares that the task of refuting Spencer's doctrine of the unknowable is merely flogging a dead horse, and he expresses surprise that "a man of extraordinary keenness and vigor of thought should waste so much speculation upon the subject." The aforesaid writer in "Science" is also greatly scandalized that the metaphysician Lacy is so grossly ignorant of the rudiments of physical science, and he takes some pains to expose the author's blundering stupidity in regard to the first law of motion. But the curious thing about it is that the writer in "Science" is inclined to attribute the scientific incapacity of this metaphysical author to Spencer himself, or, rather, to make it a result of familiarity with Spencer's works. He says: "Meanwhile, let the case serve as a warning to those who imagine that our American public is to receive useful instruction in elementary physical science from the now popular works of the great teacher of the evolution philosophy. Here is a very good student, indeed—diligent, logical, and ingenious. What philosopher could hope for a better? He has carefully studied Mr. Spencer's works, and this is what he has got out of them." A gem of judicial criticism, truly, of which "Science" may well be proud!

Indiana: Department of Geology and Natural History. Eleventh Annual Report, 1881. Pp. 414, with 55 Plates. Twelfth Annual Report, 1882. Pp. 400, with 38 Plates. By John Collett, State Geologist. Indianapolis, Ind.

Indiana possesses much geological interest. The formations, from the Lower Silurian to the Carboniferous, are well exposed in their order from east to west, and abound in limestones and sandstones suitable for varied economical purposes, lime, cement, and coal, while the northern part of the State is deeply covered with glacial drift. Springs and streams abound. The soil in the central and northern parts is deep, and contains the elements of a prolonged fertility. As late as 1880 timber was spoken of in Professor Collett's report as still in excess. It is of hard wood, and suitable for fine work. Coal is found in fields covering an area of 7,000 square miles, which are entered in all directions by railroads. The non-caking "block-coal" is found within an area of 600 square miles, and is a valuable metallurgical agent. The coal-mines employ a capital of $2,500,000, and the same sum represents the value of the product of 1882. The building-stones are of various and excellent qualities. The oölitic limestone of Lawrence, Monroe, Owen, Crawford, Harrison, and Washington Counties is easily worked, develops in hardening a strength of from 10,000 to 12,000 pounds to the square inch, takes on an agreeable color, is of unprecedented purity, and gives a promise of durability. Pure glass sand is found in four counties, gravel is "common as air," lime and cement are "so abundant as to escape attention"; brick-clay is "as common as water"; kaolin and fire-clay occur in workable beds, natural gas is mentioned, and some salt is produced. Fine fossils abound in all the formations. Professor Collett has added much to the value of his reports by calling in the aid of persons already familiar with the geology of the State and their own counties, and of scientific experts. In these volumes and the preceding report for 1880 we have, besides the special surveys of ten counties, descriptions of fossils by Dr. J. C. McConnell, of Washington, D. C., Professor James Hall, and Dr. C. A. White; a paper on palæozoic botany, by Professor Lesquereux; a flora of the elevated region of the State; and a microscopic study of potable waters, by the Rev. Dr. Curtis. Special attention is given to archæological features.

A Text-Book of the Principles of Physics. By Alfred Daniel, M. A., Lecturer on Physics in the School of Medicine, Edinburgh. London: Macmillan & Co. Pp. 653. Price, $5.

In its general method this book follows the "mode of teaching under which the whole of natural philosophy is regarded as substantially a single science, in which scattered facts are collected and co-ordinated by reference to the principles of dynamics and the great experimental law of the conservation of energy." The treatise confines itself strictly to the field denoted by its title, applications of principles and matters of solely historic interest being rigidly excluded. After some preliminary considerations of measurements, including the measurement of force and of energy, there is a chapter devoted to kinematics, in which waves and simple harmonic motions are treated at considerable length. The essential or general properties of matter are next stated, and then the characteristics of each of the three states of matter. The opening of the chapter on heat well illustrates the character of the book, and is as follows:

Heat is a form of energy. It would, perhaps, indeed be more correct to say that we designate under the one name heat two totally distinct forms of energy. The one of these is the energy of a wave motion in the ether, passing from a hot body to surrounding objects across the intervening space, as from the sun to our earth, or from a hot fire to the colder objects upon which it shines: this we call radiant heat. The other form is a confused oscillatory disturbance of the particles of a body: in virtue of this molecular movement a body may appear to our cutaneous sense of heat (a sense quite distinct from that of touch) to be more or less hot or warm; or, in the converse case it may, on account of the small amount of this movement, appear to be relatively cool or cold. The latter form of heat may be called sensible heat, or heat simply, and of it we shall proceed to treat in this chapter.

"Of Ether-Waves" is the heading under which the phenomena of radiation, including reflection, refraction, and interference, are treated. In defining electricity and magnetism, the author states that they "are not forms of energy; neither are they forms of matter. They may, perhaps, be provisionally defined as properties or *conditions of matter;* but whether this matter be the ordinary matter, or whether it be, on the other hand, that all-pervading ether by which ordinary matter is everywhere surrounded, is a question which has been under discussion, and which may now be fairly held to be settled in favor of the latter view." Although the author, in his preface to this solid volume, expresses the modest hope that it may "be found fitted to serve as an elementary introduction" to a course of wider reading and practical study, it is by no means a book for immature students. It is illustrated with about two hundred and fifty diagrams.

The Relation of Animal Diseases to the Public Health. By Frank S. Billings, D. V. S., etc. New York: D. Appleton & Co. Pp. 446. Price, $4.

The subject considered in this volume is one of great practical importance both to individuals and to the community at large. The author is a veterinary surgeon of eminent standing, a graduate of the Royal Veterinary Institute of Berlin, and honored by various kindred institutions and societies. In addition to the qualifications thus attested, Dr. Billings has another excellent requisite for the task he has undertaken, which is deep feeling upon the subject—an interest inspired of large knowledge—in fact, an intense enthusiasm well suited to the kind of work he has in hand. He writes with vigor, and often with a vehemence that might involve exaggerated statement; but we must remember that his work is not a treatise on veterinary practice, or a manual of medical and surgical treatment of diseased animals, addressed to the profession. It is a work on the *prevention* of disease, addressed to the general intelligence of the community, and designed to draw attention to questions and to stir up a popular interest in them that shall lead to private and public action, and for this purpose strong language is entirely justifiable. His subject, moreover, is one upon which there is not only much ignorance among otherwise well-informed people, but upon which there is also a great deal of narrow and unworthy prejudice, deserving of unsparing exposure and severe denunciation.

The work is divided into three parts. The first, of 208 pages, is devoted to "The Diseases of Domestic Animals"; Part II, of 155 pages, describes the "History of Veterinary Medicine" and the establishment of veterinary schools; Part III, of 51 pages, treats of "The Means of Prevention" by veterinary schools and institutes and a veterinary police system in the United States. The first part is taken up with a consideration of some of the most important infectious and contagious diseases of animals—those which require both scientific knowledge and official authority for examination and repression. An intelligent writer in "The Journal of Comparative Medicine and Surgery" thus refers to the subjects here discussed:

"Trichiniasis" in men and animals is dealt with in pages 1 to 40, and is a capital study indeed. The ready detection of the disease in slaughtered hogs, about the pillars of the diaphragm, is especially important. But the author has Bismarckian views about the "great American hog," which may raise an unjust howl from those whose pockets will be touched. We hope they will, for the intrepid doctor is fully capable of dealing with them, and he should have his chance. It will be a hard fight and a good one. Before Government acts in the matter, all large pork-packers should have skilled examiners, licensed from some good veterinary college, to inspect and mark their products. These will find a more ready sale, at higher prices, than less well-attested articles. These certificates will doubtless have a higher standing than those of some Government officials, appointed for some political reasons only or mainly.

Next to hogs, *trichinæ* are apt to infest rats, and the doctor says: "Continued examinations of rats should be made in all parts of the country, and their slaughter encouraged in all legal ways. In this regard we can even look upon the rat-pit as serving a useful public purpose, and the rat-invasion theory, with reference to hogs, will receive a sooner final settlement." But Mr. Bergh will surely interfere here, and, when Greek meets Greek, will come the tug of war. The directions for the prevention of trichinæ in swine, p. 31, are excellent, although little is said about disinfection, above which cleanliness, inspection, branding diseased hogs, etc., are preferred.

"Hog-cholera" occupies pages 41 to 50. This chapter is short, but excellent. The cause of the disease, *Bacillus suis*, is well tracked down, the microscopical examinations well given, and the preventive measures thorough — down, in extreme cases, to slaughtering the infected animals in their own pens, and burning the latter, with all contaminated wooden utensils. Sheep and rabbits are subject to what is called "hog-cholera," and require attention in places where the disease prevails.

"Tape-worm" in hogs and cattle is treated of in a short but masterly way. The *Tænia medio-canellata* comes from beef, which is especially dangerous when eaten raw or very rare. *Tænia solium* comes from pork, and affects those who eat raw ham and underdone pork, and slightly smoked and cooked sausages. This chapter should have had a distinct heading, which is lacking, and may be overlooked by all who do not read the book regularly and carefully through. The same suggestion applies to the chapter on "Foot-and-Mouth Disease," or *contagious eczema* of cattle. This infection is also apt to implicate sheep, swine, goats, deer, occasionally horses, and sometimes dogs and turkeys. Cases in children in New York have occurred, apparently from the use of contaminated milk; and the disease is cropping up in various parts of the country, both far North and far West. It has possibly been imported by English cattle which have escaped quarantine inspection, although the spontaneous generation of a similar disease, where cattle live in marshes and filth, can not well be denied. Eczema, or salt-rheum, is the most common skin affection in human beings, and how much of it comes from cattle is not yet determined. Bollinger says: "Notwithstanding the ruling opinion to the contrary, the disease is much more common among human beings than is suspected." The suggestion of Dr. Billings, that milk should be examined for much more than mere dilution with more or less pure water, is worthy of all consideration. This suggestion receives still greater emphasis in the chapter on "Tuberculosis in Cattle," pages 52 to 74, which is all too short, although pregnant with information. The credit of first calling attention to this dire disease is given to Gerlach, to whom Dr. Billings has dedicated his book. The notion that pulmonary consumption may be conveyed by the milk of tuberculosis in cows is not a pleasant one. In the opinion of the reviewer, consumption is often a foul-air disease, caused quite as much, and even oftener, by inhaling foul air, as from mere exposure to cold and wet. Dr. Billings says, "In Germany, where the majority of the milch-cows are stall-fed, and that, too, in poorly-ventilated, ill-arranged, and filthy stables, this disease has acquired an extension of which we can at present make no appreciation in this country," although we have an inkling of it among swill-fed cows. Bollinger reproduced the disease in pigs, calves, lambs, and rabbits, fed on milk from tuberculous cows. Billings is undoubtedly right when he says, page 73, that "such milk does contain elements of a specifically infectious character, and there is no question that laws should be made, and executed also, to prevent the sale of such milk for human consumption, either by itself, or mixed with other milk, in no matter how small quantities. No such milk should be sold. The specific infection of milk from tuberculous cows is no trifling matter; it is one of life and death." Consumption, scrofula, and marasmus are only too common among the hundreds of thousands of babies that are yearly brought up on poor cow's milk. However important trichiniasis may be, this far exceeds it.

Every consumptive cow should be branded by expert men. Its milk can only be given with safety to swine, after being boiled; and, although the notion is not a nice one, the doctor thinks they should be fattened and killed, as the meat is not injurious when well cooked. It is to be presumed that even "the eaters of lights" will not consume the lungs of such animals, and the liver and kidneys also must be viewed with much suspicion.

The Relations of Mind and Brain. By Henry Calderwood, LL. D. New York: Macmillan & Co. Pp. 527.

The metaphysician Sir William Hamilton, Professor of Logic in the University of Edinburgh, got embroiled in controversy with the phrenologists, and paused in his career of abstract speculation to make investigations into brain-structure, skull-measurement, and alleged "bumps" of faculty, and all for the confutation of phrenological doctrine. Another metaphysician of Edinburgh seems to have encountered a similar difficulty in his prosecution of the subject of mind. His main studies had been in the region of mental philosophy, as pursued by the old school, without especial reference to its corporeal foundations in the nervous structures of organized beings. But the modern scientific movement set so strongly in the direction of physiological inquiries, or the extension of cerebral psychology, that Dr. Calderwood found it necessary to pause, as his great predecessor had done before, and give attention to the new questions that have arisen from the study of the organic side of the subject.

Dr. Calderwood is unquestionably well imbued with the spirit of the scientific method, as is shown both by his recognition of the necessity for the systematic study of bodily conditions to any one who would arrive at a true understanding of mental phenomena, and also by the systematic character and evident thoroughness of his studies in the nervous system. His volume has interest from this point of view, quite independent of any special conclusions at which he has arrived. The first edition was published in 1879, and met with so favorable a reception that he has found it desirable, from his own ripening views and from important contributions that have been recently made to the subject of animal intelligence, to revise it, and publish the second edition, which has now appeared. While Dr. Calderwood has, of course, a large appreciation of the importance of the organic factors in psychical science, it need hardly be said that he writes very much in the interest of the old mental philosophy, and against what he regards as the inordinate claims of materialistic doctrine. The object of his book, as he says, "is to ascertain what theory of mental life is warranted on strictly scientific evidence," and nothing certainly can be more significant of the progress of mental philosophy than this unreserved acceptance of the strictly scientific method in its pursuit, and the acknowledged necessity there is of studying organic derangements in connection with mental aberrations, and of studying the psychical manifestations of inferior animals, if a valid and comprehensive theory of mind is to be reached.

The Fertilization of Flowers. By Professor Hermann Müller, translated and edited by D'Arcy W. Thompson, B. A. With a Preface by Charles Darwin. Illustrated. London and New York: Macmillan & Co. Pp. 669. Price, $5.

This comprehensive book is a collection of all the latest information upon a subject which pertains to the relations of two sciences—botany and entomology. It was not until the close of the last century that the true nature and significance of flowers began to be perceived, and we are indebted to Sprengel for the earliest true explanations of the most important phenomena in the life of flowers. From that time onward observations have accumulated and explanations multiplied until the present age, when the whole subject received a new impulse and took a new direction under the influence of the Darwinian school. Of the book before us, which is quite a cyclopædia of the subject, Mr. Darwin says in the prefatory notice, which was one of the very last of his writings:

> The publication of a translation of Hermann Müller's "Die Befruchtung der Blumen," etc., will without doubt be a great service to every English botanist or entomologist who is interested in general biological problems. The book contains an enormous mass of original observations on the fertilization of flowers, and on the part which insects play in the work, given with much clearness and illustrated with many excellent woodcuts. It includes references to everything which has been written on the subject; and in this respect the English edition will greatly exceed in value even the original German edition of 1873, as Müller has completed the references up to the present time. No one else could have done the latter work so well, as he has kept a full account of all additions to our knowledge on this subject.
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> Any one who will carefully study the present work, and then observe for himself, will be sure to make some interesting discoveries; and, as the references to all that has been observed are so complete, he will be saved the disappointment of finding that which he thought was new was an already well-known fact.

The Unity of Nature. By the Duke of Argyll. New York: G. P. Putnam's Sons. Pp. 571. Price, $2.50.

This work is a sequel to "The Reign of Law," published in 1866. It is of philosophical import, and devoted to the discussion of many of the most important questions and problems concerning the order and government of nature, which have come into great prominence in new forms in the present age. It is written from the orthodox stand-point, is full of acute criticisms, displays a wide familiarity with the results of science, is full of controversy, and is an elegantly printed and very handsome book—as becomes its ducal authorship.

For Mothers and Daughters: A Manual of Hygiene for the Household. By Mrs. E. G. Cook, M. D. New York: Fowler & Wells. Pp. 292. Price, $1.50.

The author has spent many years in studying the causes of the sufferings of women and trying to relieve them. Believing that they came of ignorance or violation of Nature's laws, she has composed this work to point out those laws, and direct such women as it can influence to return to them. In it are discussed, briefly, the ordinary subjects of hygiene, and the special functions of women, and such principles are inculcated as may induce women to take care of their health, and make themselves fit for the proper and effective accomplishment of the purpose around which the objects of their life center.

An Essay on the Philosophy of Self-Consciousness. By P. F. Fitzgerald. Cincinnati: Robert Clarke & Co. Pp. 154. Price, $1.25.

In this essay the author has aimed to give an analysis of reason and the *rationale* of love. He believes he has made three discoveries regarding the intellectual, the affectional, and the moral nature of man: 1. "That the substance or hypostasis of thought is Being—the Being of the individual Ego being in every case the stand-point of rational judgment"; 2. That the affections or emotions are essentially correlative and reciprocal in their nature—or that attraction in the spiritual world is reciprocal and complementary; and, 3. That in the rational being, "joy of life is only completely attained through realization of the ideals of feeling, thought, and will."

Hand-Book of Tree-Planting. By Nathaniel H. Egleston. New York: D. Appleton & Co. Pp. 126. Price, 75 cents.

The author of this "Hand-Book" will be remembered by the readers of "The Popular Science Monthly" as having contributed to it, in 1881, 1882, and 1883, a number of valuable articles on subjects relating to forestry. The present book relates to the same subject, that is, to the planting of trees in masses, and aims to meet the wants of land-owners, more especially of those whose lot is cast in portions of the country destitute, or nearly so, of trees, and who feel the need of them, but are inexperienced in their cultivation. It is divided into four parts—"Why to plant; when to plant; what to plant; and how to plant"—the questions coming under each of which heads are answered clearly and in a plain, practical, common-sense manner. The treatise, besides having the qualities just referred to, is lucid and simple in its literary construction, brief, interesting, instructive, comprehensive, and withal convenient in size for the hand or the pocket; and it offers a complete exemplification of what a manual on any practical subject for plain men ought to be.

Protection to Young Industries, as applied in the United States. A Study in Economic History. By F. W. Taussig, Ph. D., Instructor in Political Economy in Harvard College. New York: G. P. Putnam's Sons. Pp. 72.

This instructive monograph on one of the most prominent points in the political economy of protection was originally written in competition for the Toppan Prize in Political Science at Harvard University, and received that prize in October, 1882. The writer carefully examines the history of the cotton, the woolen, and the iron manufactures of this country, with reference to the influences that have been operative in their development, and the result is thus given in his concluding remarks.

> The three most important branches of industry to which protection has been applied have now been examined. It has appeared that the introduction of the cotton-manufacture took place before the era of protection, and that—looking aside from the anomalous conditions of the period of restriction from 1808 to 1815—its early progress, though perhaps somewhat promoted by the minimum duty of 1816, would hardly have been much retarded in the absence of protective duties. The manufacture of woolens received little direct assistance before it reached that stage at which it could maintain itself without help, if it were for the advantage of the country that it should be maintained. In the iron-manufacture, twenty years of heavy protection did not materially alter the proportion of home and foreign supply, and brought about no change in methods of production. It is not possible, and hardly necessary, to carry the inquiry much further. Detailed accounts can not be obtained of other industries to which protection was applied; but, so far as can be seen, the same course of events took place in them as in the three whose history we have followed. The same general conditions affected the manufactures of glass, of earthenware, of paper, of cotton-bagging, sail-duck, cordage, and other articles to which protection was applied during this time with more or less vigor. We may assume that the same general effect, or absence of effect, followed in these as in the other cases.

Federal Taxation. By Samuel Barnett. Pp. 45. Richmond, Va.: Andrew Baptist & Co.

This pamphlet is made up of a collection of editorials which appeared in the "Atlanta Constitution." They consist of independent criticisms of our national policy in regard to taxation, expressed with great force and freedom. The writer places a high estimate on the value of the Federal Union, but thinks it would be worth more if it cost less. While its benefits are inexpensive, its abuses are costly. Free trade between the States, which Mr. Barnett thinks the chief advantage of the Federal Union, costs nothing; while "protection" is more expensive than the government itself. The tax policy of the Federal Government, carried on by protection, he declares to be bad in theory and even worse in practice; and that few, of even public men, have the faintest conception of how bad it is. Mr. Barnett proclaims a very important truth when he says that "nothing short of a *quantitative study* of its impositions can properly expose them; the pretty fallacies of protection melt like wax in the fire of quantitative analysis." The treatment of the several topics is rather suggestive than systematic, but the pages are full of telling facts, and many hard blows are dealt upon the system of organized corruption which shelters itself under the false pretense of protection.

"The Kansas City Review of Science and Industry." Edited by Theodore S. Case. Kansas City, Mo.: Monthly, 64 pp. Price, $2.50 a year.

With its May number this magazine begins its eighth year. The "Review" is doing an excellent work in stimulating an interest in science in the rapidly growing country west of the Mississippi. But very few of its articles are solely of local interest; a wide range of sciences is represented in its pages, while manufactures and the arts based upon science, including education, are by no means neglected.

"The Canadian Record of Natural History and Geology, with Proceedings of the Natural History Society of Montreal." Vol. I, No. 1. J. T. Donald, M. A., Editor. Montreal, January, 1884.

This magazine takes the place of "The Canadian Naturalist," until last June published for the above-named society by the Messrs. Dawson Brothers. The "Record" is to be published quarterly, and, in addition to the society's proceedings, will contain original papers on scientific subjects by Canadians, and reprints of scientific papers of merit published elsewhere, which deal with Canadian subjects. The first number contains a report of the second annual meeting of the Royal Society of Canada, held at Ottawa in May, 1883; two short papers on geological subjects, by Principal J. W. Dawson; and an extended account of "The Athabasca District of the Canadian Northwest Territory," by the Rev. Émile Petitot. There are also three short papers by the editor, and part of a memorial address on the late James Richardson.

A Text-Book of Inorganic Chemistry. By Professor Victor von Richter, University of Breslau. Translated by Edgar F. Smith, A. M., Ph. D. Philadelphia: P. Blakiston, Son & Co. Pp. 424. Price, $2.

Professor von Richter's treatment of his subject is characterized by an effort to show how the possession of a few facts leads to the formation of scientific theories, and the theories in turn show the investigator where to look for new facts. "The Periodic System of the Elements," or "Mendelejeff's Table," is made the basis of the work, and considerable attention is given to thermo-chemical phenomena, the periodicity of which is brought prominently forward. There is a short chapter on "Crystallography," with diagrams, and one on "Spectrum Analysis." The volume is illustrated with a colored plate of spectra, and eighty-nine woodcuts.

PUBLICATIONS RECEIVED.

The Past and the Present of Political Economy. By Richard T. Ely, Ph. D. Baltimore: N. Murray. Pp. 64.

"The Journal of Physiology." Vol. V, No. 1. Edited by Michael Foster, M. D. Baltimore: N. Murray. Pp. xii–484. $5 a year.

An Investigation locating the Strongest of the Bronzes. By W. H. Ernest H. Jobbins, M. E. Pp. 43.

Aneurism of the Femoral Artery, and a Knife-Wound of the Intestines. By W. O. Roberts, M. D. Louisville, Ky. Pp. 11.

Esplorazione di un Shell-mound Indiano presso Nueva Orleans, Luisiana. (Exploration of a Shell-Mound near New Orleans, La.) By R. W. Shufeldt, U. S. Army. Florence, Italy. Pp. 11.

Studies from the Biological Laboratory of Johns Hopkins University. H. Newell Martin, D. Sc., and W. K. Brooks, Ph. D., Editors. Baltimore: N. Murray. Pp. 48, with Six Plates. 70 cents.

The Glacial Boundary in Ohio, Indiana, and Kentucky. By Professor G. Frederick Wright. Cleveland, Ohio: Western Reserve Historical Society. Pp. 86.

The Determination of the Flashing Point of Petroleum. By John T. Stoddard. Pp. 6.

What and Why. By Charles E. Pratt. Boston: Pope Manufacturing Company. Pp. 72.

The Mormon Question. By J. W. Stillman. Boston: J. P. Mendum. Pp. 40.

Massachusetts Agricultural College, Report for 1883. Boston: Wright & Potter Printing Company. Pp. 73.

Sanitary Drainage of Tenement-Houses. By William Paul Gerhard, C. E. Hartford: Cox, Lockwood, and Brainard Company. Pp. 40.

Methods of Historical Study. By Herbert B. Adams, Ph. D. Baltimore: N. Murray. Pp. 136. 50 cents.

The Postal Telegraph. Speech by Hon. John A. Anderson, of Kansas. Washington. Pp. 23.

Notes on the Literature of Explosives. By Professor Charles E. Munroe, U. S. N. A. Pp. 29.

"Home Science Monthly." Vol. I, No. 1. New York: Selden R. Hopkins. Pp. 112. $2.50 a year.

Memoirs of the Boston Society of Natural History (Carboniferous Myriapods and Cockroaches). By Samuel H. Scudder. Boston: Published by the Society. Pp. 27, with Two Plates.

Reports on the Cotton Production: Of the State of Texas. Pp. 173. In the Indian Territory. Pp. 84. Of the State of Arkansas. Pp. 116. By R. H. Loughridge, Ph. D. Berkeley, Cal.: From the Tenth Census Report.

Der freie Wehrman als Träger der darwinischen Sittlichkeit und sozial Reform. (The Free Warrior as a Pillar of Darwinian Morality and Social Reform.) By John H. Becker. Berlin.

Katy Neal: A Comedy of Child-Life. By Charles Bernard. New York: Harold Roorbach. Pp. 46. 15 cents.

The American University. By Professor John W. Burgess, Ph. D. Boston: Ginn, Heath & Co. Pp. 22. 15 cents.

Fertilizers: Greensand Marl. By Dr. C. A. Greene. Harrisburg, Pa. Pp. 29.

Real and Imaginary Effects of Intemperance. By G. Thomann. New York: United States Brewers' Association. Pp. 167.

The Necessity of an Ambulance System in Chicago. By G. Frank Lydston, M. D. Chicago: A. G. Newell. Pp. 8.

Modern Sanitation. By G. Frank Lydston, M. D. Chicago: A. G. Newell. Pp. 23.

Geological Survey of New Jersey. Report for 1883. By George H. Cook, State Geologist. Pp. 188.

Q. P. Index Annual, 1883. Bangor, Me.: Q. P. Index, Publisher. Pp. 86.

History of the Discovery of the Circulation of the Blood. By Henry C. Chapman, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 56. $1.

The Parlor Muse. New York: D. Appleton & Co. Pp. 96. 30 cents.

English as She is Spoke: With an Introduction by James Millington. New York: G. P. Putnam's Sons. Pp. 56. 50 cents.

Beginnings with the Microscope. By Walter P. Manton, M. D. Boston: Lee & Shepard. Pp. 73. 50 cents.

Trafalgar: A Tale. By Perez Galdos. From the Spanish by Clara Bell. New York: W. S. Gottsberger. Pp. 255.

Lectures on Light. By G. G. Stokes, F. R. S. London: Macmillan & Co. Pp. 133. 75 cents.

Systematic and Descriptive Mineralogy. By J. H. Collins, F. G. S. New York: G. P. Putnam's Sons. Pp. 829. $1.25.

The Clew of the Maze and the Spare Half-Hour. By the Rev. Charles H. Spurgeon. New York: Funk & Wagnalls. Pp. 190. 75 cents.

"Science Ladders." Nos. 1 to 6. By N. D'Anvers. New York: G. P. Putnam's Sons. Pp. about 400. $1.50.

Brain-Exhaustion. By J. Leonard Corning, M. D. New York: D. Appleton & Co. Pp. 234. $2.

The Consolations of Science. By Jacob Straub. Chicago: The Colegrove Book Company. Pp. 435.

The Outskirts of Physical Science. By T. Nelson Dale. Boston: Lee & Shepard. Pp. 187. $1.25.

Six Centuries of Work and Wages. By James E. Thorold Rogers, M. P. New York: G. P. Putnam's Sons. Pp. 591.

The True Theory of the Sun. By Thomas Bassnett. New York: G. P. Putnam's Sons. Pp. 263. $3.

"The Globe Pronouncing Gazetteer." Edinburgh: Oliver & Boyd; New York: G. P. Putnam's Sons. Pp. 462, with 32 Maps.

Sorghum: Its Culture and Manufacture economically considered. By Peter Collier, Ph. D. Cincinnati: Robert Clarke & Co. Pp. 582. $3.

Machinery of the Heavens. By A. P. Pichereau. Galesburg, Ill.: The Author. Pp. 142. $1.50.

In the Heart of Africa. By Sir Samuel W. Baker; condensed by E. J. W. New York: Funk & Wagnalls. Pp. 286. $1.

Pine Needles, or Sonnets and Songs. By Heloise Durant. New York: G. P. Putnam's Sons. 1884. Pp. 160.

Geology and Mineral Resources of the James River Valley, Virginia. By J. L. Campbell, LL. D. New York: G. P. Putnam's Sons. Pp. 119. $1.

The Woman Question in Europe. Edited by Theodore Stanton. New York: G. P. Putnam's Sons. Pp. 478. $3.50.

Report of the Commissioner of Agriculture for 1883. Washington: Government Printing-Office. Pp. 496.

Mental Evolution in Animals. By George John Romanes, F. R. S. New York: D. Appleton & Co. Pp. 411. $2.

A Graveyard Flower. By Wilhelmine von Hillern. From the German, by Clara Bell. New York: William S. Gottsberger. Pp. 160.

A Manual of Psychological Medicine and Allied Nervous Diseases. By Edward C. Mann, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 699. $5.

POPULAR MISCELLANY.

The British Association.—The British Association will meet in its fifty-fourth annual session at Montreal, August 27th, under the presidency of Lord Rayleigh. The Vice-Presidents will be the Governor-General of Canada (Lord Lansdowne), Sir John A. Macdonald, Sir Lyon Playfair, Sir Alexander T. Galt, Sir Charles Tupper, Sir Narcisse Dorion, Hon. Dr. Chauveau, Principal J. W. Dawson, Professor Edward Frankland, Dr. W. H. Hingston, and Dr. T. Sterry Hunt. Professor A. W. Williamson will be General Treasurer; Captain Douglas Galton and A. G. Vernon Harcourt, General Secretaries; Professor T. G. Bonney, Secretary; L. E. Dawson, R. A. Ramsay, S. Rivard, S. C. Stevenson, and Thomas White, M. P., Local Secretaries; and Mr. F. Wolferstan Thomas, Local Treasurer. The Presidents of the Sections will be: A, Mathematical and Physical Science, Sir William Thomson; B, Chemical Science, Professor H. E. Roscoe; C, Geology, W. T. Blanford; D, Biology, Professor H. N. Moseley; E, Geography, Colonel Rhodes and P. L. Sclater, Vice-Presidents; F, Economic Science and Statistics, Sir R. Temple; G, Mechanical Science, Sir F. J. Bramwell; H, Anthropology, Professor E. B. Tylor. It is expected that the public lectures will be by Mr. Crookes, Dr. Dallinger, and Professor Ball. The special discussions will be: Friday, August 29th, "The Seat of the Electro-motive Forces in the Voltaic Cell"; and Monday, September 1st, "The Connection of Sun-Spots with Terrestrial Phenomena." Most liberal provisions have been made by the Canadians for the accommodation and entertainment of their guests. The expenses of fifty officers are guaranteed; the Dominion Parliament has appropriated $14,000 toward the expenses of ordinary members; the steamship companies have made considerable reductions of fares; members of the Association are invited to bring their wives and two near relatives with them; the Canadian Pacific Railway offers free excursions to one hundred and fifty members from August 1st till the grand excursion to the Rocky Mountains; and other excursions have been provided for or are contemplated, among which is the excursion to the American Association, which meets in Philadelphia, September 3d.

Death of Professor Klinkerfues.—Professor C. A. Eggert, of the University of Iowa, has kindly furnished us with the following facts respecting the life and work of Professor F. W. Klinkerfues, of the University of Göttingen, one of the most prominent astronomers in Germany, who died by suicide—provoked, it is supposed, by pecuniary losses and excessive use of intoxicating liquors—on the 28th of January last: Professor Klinkerfues was born at Hofgeismar in 1827, and very early manifested a decided taste for astronomical studies. He became a pupil of Gauss, who recognized his very remarkable mathematical talents. Some of his earlier efforts were afterward incorporated, with but little change, in his "Theoretical Astronomy," a work of decided merit. Two of them deserve special mention: one, a new method of calculating the course of a comet from one incomplete and two complete observations; and the other, for the computation of the orbits of double stars. His hypothetical method for the determination of the distance of certain fixed stars belonging to the same system was applied with a satisfactory result to Sirius. Other of his hypothetical combinations were bold and successful in a high degree. Thus, he predicted a close relation between the meteoric shower of November 27, 1872, from the constellations Perseus and Andromeda, and Biela's comet, and that the comet would be found in the opposite quarter of the sky. He telegraphed to the director of the observatory in Madras: "Biela's comet has touched the earth. Look for it in Centaur, near the star ϑ." The comet was found at the spot indicated. Professor Klinkerfues was the discoverer of comets III, 1853; III, IV, 1854; III, 1857; V, 1857, and II, 1863. He was best known in Germany for his predictions of the weather, which he based on the hygrometric indications of moisture in the air. Their fault was, that they depended on the indications at the surface, while the weather goes by the proportion of moisture in the upper strata of the atmosphere, which may be very different. His instrument, known as the Klinkerfues hygrometer, met with considerable success for a time, but was ultimately found to be of little practical value, and is not much used now. Although Professor Klinkerfues was no more successful in other points as a weather-prophet, he has enriched meteorology with observations and facts of some importance; and it would be unjust to classify him with the noisy charlatans whom our newspapers hoist into temporary fame. Notwithstanding his mistakes, the death of such a man is a loss to science. Supplemented by careful observations, his hypotheses on astronomical matters often approached mathematical certainty, and it is not easy to say how much he might yet have accomplished but for the abrupt and melancholy closing of his career.

Facts about British Stature.—The Anthropometric Committee of the British Association, after several years of labor, made its final report at the recent meeting of that body. The committee was appointed for the purpose of "collecting observations in the systematic examination of the height, weight, and other physical characters of the inhabitants of the British Isles," and, in performing its work, took all sorts of measurements of people of all classes, of all ages, and of both sexes, living in all parts of Great Britain, and, to a small extent, of persons living in Ireland. The measurements or observations covered twelve points by which man is externally distinguished from man, and were made upon thousands of people. We notice a few of the more striking results: In average height, the Scotch stand first (68·61 inches), the Irish second, the English third, and the Welsh fourth, while in weight, the Scotch still leading with 165·3 pounds, the Welsh are second, the English third, and the Irish fourth. In the light of these two results, the London "Times" observes that the Scot will look upon the discovery made by the committee "as simply giving the hall-mark of science to his own instinctive conviction that he is a much better man in all respects than the 'fausse southron.'" As between the sexes in England, the average stature of adult males is 67·36 inches, and that of adult females 62·65 inches, while the average Englishman weighs 155 pounds, and the Englishwoman 122·8 pounds. In strength, the Englishman can draw a bow with a power of 77½ pounds, while the woman brings to bear a force 35 pounds less, or a little more than half as much. In complexion, the lighter shades rule over the country as a whole, but a large percentage of dark complexions stretch in a band across the center of England and Wales. The inhabitants of the more elevated districts appear to possess a greater stature than those of the alluvial plains, and those of the northern and colder districts than those of the southern and warmer parts of the island; those of the northeastern and drier regions are taller than those of southwestern and damper climates. A comparison with American army statistics does not show that the Anglo-Saxon race reaches a higher stature here than in England, as some have claimed, but that a close correspondence prevails between the two groups. Compared with other nationalities in stature, except as to a few extraordinarily tall Polynesians, the English professional class head the list, and the Anglo-Saxon race takes the chief place among civilized communities, though it might stand second to the Scandinavian countries if a fair sample of their population could be obtained. Other general facts deduced from the examinations, as true in the British Isles at least, are that an open-air country life is more favorable to height and weight than a sedentary town life; that favorable hygienic and sanitary conditions have a marked influence on growth and weight; that lunatics show a deficiency of weight and stature, and criminals a greater one, indicating a lack of physical as well as mental stamina in both these classes; that athletes appear a little taller than the general population, and not as heavy; that growth diminishes, as we descend in the social scale, to a difference of five inches between the average stature of the best and most nurtured classes of children of corresponding ages, and of three and a half inches in adults. The population of the manufacturing towns do not appear to be degenerating, but exhibit a slight but uniform increase in stature, and a large increase in weight.

Darwinism in the Talmud.—Dr. B. Placzek, of Brünn, has collected citations from the Talmud to show that the old Jewish writers were keen observers of Nature, and had ideas akin to Darwinism. Joseph Albo, in the fifteenth century, suggested the thought of compensation, or interchange of relations, in an hypothesis that cattle are defective in teeth because so much of the tooth-stuff goes to horn, and that they make up for the resultant deficiency in their powers of mastication by the faculty of chewing the cud. Other writers noticed that the integrity of the comb of the cock had much to do with its masculine potency, and that other birds suffer in spirit and vigor when deprived of their ornamental appendages. A writer in the "Agada" affirmed, in justification of Solomon's selection of the ant as an example of wise industry, that it builds its houses in three stories, and stores its provisions, not in the upper compartment, where they may be rained on, nor in the lower, where they will gather dampness, but in the middle one, the safest place, and that it gathers all it can. The ant is also a fit type of honesty, for it regards the property of its neighbors, and will not rob. Once, it is said, when an ant dropped a grain of corn, a number of other ants came up and smelled of it, but let it lie till the owner came up and took it away. Simon ben Chalafta, "the Experimenter," tells of an experiment worthy of Lubbock. On a very hot day he put a cover over an ant-hill. A sentry ant came out, observed the shadow, and reported upon it to his fellows. They came out to enjoy the coolness of the shade, when it was suddenly taken away, and the insects, irritated by the burning sun, fell upon the scout that had led them into the trap, and killed him. The Agadists make much of the devotion of the individual ant to the welfare of the whole colony as a salient point of formic character. Dr. Placzek suggests that Solomon may have been acquainted with a kind of agricultural ants from his sentence, "Provideth her meat in the summer, and gathereth her food in the harvest," where the former verb may, in analogy with other cases of its use in the Bible, refer to the preparation of the field. Passages are quoted that point to the thought that the difference in mental gifts between men and animals is only quantitative. In one of the books, a limit is set to the scope of scientific investigation thus: "What is too high for thee, seek not to reach; what is too hard for thee, seek not to penetrate; what is incomprehensible to thee, try not to know; what remains hidden from thy mind, strive not to discover. Direct thy thought only to what is attainable, and trouble thyself not about hidden things."

Geological Catastrophes.—The Duke of Argyll, in his address to the Edinburgh Geological Society, on its fiftieth anniversary, took the ground that "nothing can be more unphilosophical than the antithesis and opposition which is set up between what is called the law of continuity and what is called the doctrine of catastrophes. Throughout all Nature, and throughout all those operations of the human intellect which depend on the manipulation of natural forces, we see the two doctrines to be perfectly harmonious—strains and tensions maintaining themselves in absolute silence up to the bending or the breaking-point—pressures pressing with tremendous but noiseless energy up to the bursting point—and then moments of rapid and sometimes of instantaneous change. If it is irrational to quote the continuity of Nature as affording any, even the least, presumption against sudden and great effects, it is still more irrational to quote it as irreconcilable with effects which, though catastrophes to us, whose scales of measurement are often the scales of pygmies, are in reality nothing but movements of infinitesimal smallness in the scale of Nature. I had occasion the other day, in delivering a popular lecture in Glasgow, to exhibit a section of the globe drawn to the scale of one tenth of an inch to a mile. On that scale, which I have taken from my friend Mr. James Nasmyth, the globe is represented by a circle sixty-four feet in diameter, and I was able to show that on that portion of the curve which represents one eighth of the circumference, the elevation of the highest mountain in Europe, Mont Blanc, was wholly invisible to the spectators who were half-way down the hall, and could barely be seen even by those who were close at hand. The truth is, that, when we come to realize the almost infinitesimal smallness of the irregularities of the earth's surface as compared with its circumference—the whole range from the highest height to the deepest deep being somewhat less than sixty thousand feet—the wonder comes to be that if subterranean forces are at work at all in modifying, from time to time, the perfect smoothness and sphericity of the surface, not that their work should be so great, but, on the contrary, that it should be so very small."

Causes of Typhoid Fever.—In a paper published by the Iowa State Board of Health on the nature, causes, and prevention of the typhoid fever of America, Dr. R. J. Farquharson, Secretary of the Board, emphasizes the distinction between typhus and typhoid, an important point of which is, he believes, that typhoid is not contagious. A number of reports, American and foreign, seem to concur in fixing the origin of the disease in some condition of the ground or water, and indicate that it may be produced by foul water, by foul air, or by emanations from the earth, occurring most frequently in the autumn and during seasons of drought. It has sometimes been traced with every evidence of probability to decayed wood, and this indicates that vegetable decay is one of the prime sources of its origin—a view which the fact that it has been produced by the drying of ponds does not contradict, but rather supports. A direct connection is traced, in the United States, between the increase of summer temperature and this disease. The curves of normal temperature, of typhoid fever, and of malarial fevers are almost exactly parallel, except that the culmination of the fever curve, in September for Iowa, October for the Eastern States, is behind that of the temperature curve, which occurs in July. A general parallelism, but without the uniformity of the culminating point of fever, has, with the exception of one spot (Munich), been observed in Europe. Since the disease is not contagious, the minute directions for isolation, disinfection, destruction of clothing, etc., so eminently proper in really contagious diseases, are useless in typhoid fever. In our present knowledge of the causes of the disease, but little can be done, and that only in a general way, to prevent it. The principal points are to see that the drinking-water is pure, that the house is well ventilated and not built over a marshy spot, that slops are removed far enough away, and that the drains are kept clean and washed and are occasionally disinfected with copperas; and, when sickness occurs, the patient should be given quiet and plenty of fresh air.

The Weather and Neuralgia.—The case of Captain R. Catlin, United States Army, as reported by Dr. S. Weir Mitchell, affords a curious illustration of a relation between neuralgic pains and meteorological condition. Captain Catlin had his foot crushed by a round shot in August, 1864. His leg was amputated below the knee. Pain was felt early as if in the lost foot, and became severe within nine months, while in other respects Captain Catlin is and has been in perfect health. Since 1871, the captain has kept a regular record of the hours of pain he suffered each year and each month. The maximum of pain was attained in 1874 and 1875. During 1876 the amount of pain fell off 100 hours (from 1,892 to 1,790), with a decrease of mean annual pressure and a corresponding increase of temperature. For 1877, pain and pressure remained constant and parallel, with some increase in temperature. In 1878 the pain decreased 200 hours, while an equally remarkable fall was shown in the barometric curve. The law of relationship of low pressure and high temperature to the amount of pain and the number of attacks of pain and the number of storms becomes more apparent in considering the quarterly and monthly distribution of pain and storm. "The winter months hold the advantage as pain-producers," while in quarterly amounts the first quarter, beginning with the winter solstice, leads; the fourth quarter, ending with the winter solstice, follows; and the second, or spring quarter, is next. In months, March holds the lead, and is closely pressed by January, after which follow November, December, May, February, April, August, October, September, July, and June. The average duration of each attack of pain during eight years was 18·97 hours. The duration also bears a relation to the amount of pain and the number of storms, and is greatest in February. To determine the average distance of the storm-center at the beginning of the pain-attack, sixty well-defined storms through ten consecutive months were taken. The average distance was six hundred and eighty miles, the particular distances ranging from two hundred to twelve hundred miles. It has been observed that eating a meal, when the pain is on, intensifies it, and it is believed that it often hastens the attack. During seven years (1875 to 1882) nine neuralgic attacks of great and unusual power were observed, and a coincidence was traced between them and storms of extraordinary intensity. The best regimen for this neuralgic subject has been found to consist in physical exercise, nutritious food, and light, agreeable occupation.

Dr. Michael Foster on School Examinations.—Dr. Michael Foster, in a recent address before a pharmaceutical school in London, gave a vigorous expression to his views respecting examinations. The passing of an examination was regarded as a mark, stamp, or certificate, of what? He ventured to think that success in this sphere of action merely indicated that the prize-man had the ability and skill to get on in an examination. No doubt a stupid and idle man could not get first places in examinations, and so the industrious and clever were picked out by the process. But it was certainly not the case that those who failed to get the highest honors in examinations went to the wall in after-life. On the contrary, he was sorry to say that he knew some who had succeeded to the fullest extent during the examinational period of their life, yet did not maintain their prestige as time rolled on. And not a few men who were signal failures at examinations have proved of enormous value in after-years. To some a vast amount of evil was wrought from the fact that no proper knowledge had been acquired to pass the standard. He advocated a plan of examination which is partly carried out at the School of Science, South Kensington. That was, to study and be examined on each subject separately, and by the same persons who had acted as teachers.

The Future of Physiological Experiment.—Professor Tyndall founds a new argument in favor of the practice of experimental physiology in the peculiar properties of infectious diseases, and their probable germ origin. One of the most extraordinary and unaccountable experiences in medicine has been the immunity secured by a single attack of a communicable disease against future attacks of the same malady. Small-pox, typhoid, and scarlatina, have been found, for example, as a general rule, to occur only once in the lifetime of the individual, the successful passage through the disorder seeming to render the body invulnerable against future attacks. Professor Tyndall had some time ago suggested to a friend that the phenomenon could be explained under the germ theory by supposing the soil, or the system, to be exhausted by the first parasitic crop, of some ingredient necessary to the growth and propagation of the parasite. Some important essays on the subject have been recently published in the "Revue Scientifique" by M. Bouley, who draws attention to the results obtained by M. Raulin in the cultivation of the microscopic plant *Aspergillus niger*. The omission of potash from M. Raulin's liquid suffices to make the produce fall to one twenty-fifth of the amount collected when potash is present. The addition of an infinitesimal amount of a substance inimical to the life of a plant is attended with still more striking results. For example, one part in 1,600,000 of nitrate of silver added to the liquid entirely stops the growth of the plant. Now, supposing the aspergillus to be a human parasite—a living contagium—capable of self-multiplication in the human blood, and of so altering the constitution of that liquid as to produce death; then, the introduction into the blood of a man weighing sixty kilogrammes, of five milligrammes of nitrate of silver would insure, if not the total effacement of this contagium, at all events the neutralization of its power to destroy life. An index-finger here points out to us the direction which physiological experiment is likely to take in the future. In anticipation of the assault of infectious organisms, the experimenter will try to introduce into the body substances which, small in amount, shall so affect the blood and tissues as to render them unfit for the development of the contagium. And, subsequent to the assault of the parasite, he will seek to introduce substances which shall effectually stop its multiplication. Dr. Polli, of Milan, has already obtained results that promise well with alkaline sulphides in certain fevers and small-pox, and Crudelli obtained similar results with arsenic against the malaria of the Roman Campagna. To enable us to administer these remedies safely and with some assurances of success, experiments must be made of their effects, on different groups of individuals, and these individuals must be animals susceptible to the infection and to the counteracting application. "I appeal," says Professor Tyndall, "not to the partisans of either side, but to the common sense of England, whether, in the interests of humanity, the proposed experiment is not a legitimate one."

Effect of School-Work on the Brain.—A question was recently asked Mr. Mundella, in the British House of Commons, as to the effect of the English educational system on the health of children and teachers. He replied in substance, availing himself of the reports of the Lunacy Commissioners, that the effect of education had been, even in the midst of a rapidly-increasing population, to diminish the absolute number of children admitted to asylums. So, of the group described as teachers, schoolmasters, schoolmistresses, governesses, professors, and lecturers, the proportion admitted to asylums was less than that of any other profession. This statement should dispose of much of what is said about the ordinary routine of school occupation leading to mental disease. While pupils who are stimulated or pressed, by cramming, to over-exertion may suffer injury, a lively exercise of the mental faculties on some varieties of subjects, which is the most that the majority of school-children attain, is more likely to be promotive of vigor. The fact that insanity prevails most among agricultural laborers in the rural counties, where the standard of education is lowest, and mental vacancy is least interrupted, tends to show that absolute blankness of mind, like the non-use of a physical faculty, promotes disease. So with teachers: while the demands on their brains are constant and call for vigorous exercise, they are, as a rule, seldom of a kind to involve overwhelming pressure, or so irregular as to admit of intervals when the mind is wholly unemployed and liable to morbid reaction.

Poisons developed in the Body. — On this subject Dr. Benjamin W. Richardson says: "In my reports to the British Association for the Advancement of Science, I have pointed out that the substance *amylene*, an organic product which can be easily constructed in vital chemical changes, produces phenomena identical with those of somnambulism and with some of the phenomena of hysteria. I have pointed out, in the same reports, that another organic product, called *mercaptan* (sulphur-alcohol), causes, when inhaled, symptoms of profoundest melancholy, and that, in the process of being eliminated by the breath, it gives to the breath an odor which is identical with the odor evolved in the breaths of many patients who are suffering from the disease called melancholia. From these observations I have ventured to suggest that various forms of mental affection and of nervous affection depend for their development on the presence in the body of organic chemical compounds, formed and distilled through an unnatural chemical process carried on in the body itself. I have endeavored to develop this subject somewhat further by my researches on the action of lactic acid on animal bodies. I have shown by experiment that this acid, diffused through the body by the blood, acts as a direct irritant upon the lining membrane of the heart, the *endocardium*, and all the fibro-serous membranes of the body, so that a synthesis of heart-disease and rheumatism can be established by its means. Lactic acid is the most copious product thrown out in the disease called rheumatic fever, and, as many of the phenomena resulting from that disease take the same form and character as those producible by lactic acid, I infer from the best evidence attainable that this acid, the product of a fermentative change going on in the body during acute rheumatism, is the cause of the secondary structural affections which so frequently follow acute rheumatism. It has been for some time past observed by several able physicians that persons who are suffering from the affection known as diabetes give off a peculiar odor from their breath—an odor which to some is like that of vinegar, to others of sour beer, to others of a mixture of ether and chloroform, to others of acetic ether. I should compare it myself to the odor of grains as it is detected in a brewery. When this odor is observed in the breath of diabetic patients, it frequently happens that they become sleepy, cold, and unconscious, with the results of coma and death. At one time it was supposed that these phenomena were uræmic, and were due to the presence of urea in the blood; but the absence of convulsion and of some other symptoms destroys this hypothesis, or at all events shakes it. It is now believed that the symptoms owe their origin to the decomposition of the diabetic sugar which is in the body, and to the production from that decomposition of a volatile ethereal fluid called *acetone*, a fluid which has been discovered in the blood and secretions of these affected persons, who are said therefore to be suffering from the disease 'acetonæmia.' From the action of acetone upon animal bodies

I infer that the theory of acetonæmia is founded on good evidence." Dr. Richardson mentions also the secondary absorption of poisonous matter from wounds, and from the abraded and ulcerating surfaces produced in diphtheria, malignant scarlet fever, etc., and concludes by saying: "Such observations as have been noticed under this short head lead to a study of another new point, namely, the possibility of the formation of organic alkaloids in the body during some conditions of disease. Scientific discovery has not, however, advanced so far as to enable me at this moment to do more than allude to one of the newest and most important studies in modern medical research."

Mechanism of Plant-Contraction.—Dr. J. Burdon-Sanderson, in a lecture before the Royal Institution of Great Britain, performed an experimental demonstration of the causes and phenomena of the excitability of plants. The number of plants which exhibit what is often called irritability is very considerable, but the illustrations of the lecture were drawn chiefly from typical specimens of only a few of the most familiar kinds, such as mimosa, dionea, and two or three others. The mimosa presents nearly the same appearance when asleep as when excited, but is then liable to a further change, by the operation of which it sinks to a still lower position and becomes limp. The excitatory effect is dependent on a vital change in the protoplasm of the cells, which may be observed when the plant is asleep as well as when it is awake. The cells of the plant, which unexcited are distended or charged with liquid, undergo on excitation a sudden diminution of tension or of expansion by the discharge of the water contained in them, which finds its way first into the intercellular air-spaces, and then out of the motor organ altogether. The discharge is due to a sudden loss of its water-absorbing power by the protoplasm of the cell, whereby the external cell-sac, whose elastic tendency to contract is kept in check only by the constantly distending action of the protoplasm, presses upon it with force enough to squeeze out the cell-contents. This action being participated in by all the individual cells, the leaf-stalk, or whatever organ it may be that droops, necessarily becomes limp and falls. The motion of the leaf is, however "the result of the action of many hundred independent cells, all of which may act together, but may not. In either case they take a great deal longer to think about it; for during a period after excitation, which amounts at ordinary summer temperature to about a second, the leaf remains absolutely motionless." During this interval an electrical disturbance takes place in the plant, the character and operation of which were neatly shown by the aid of some extremely delicate apparatus. Obvious and well-marked differences were pointed out between the mechanism of plant motion and that of animal motion; but the differences are not essential, for they depend not on difference of quality between the fundamental chemical processes of plant and animal protoplasm, but merely on differences of rate or intensity. "Both in the plant and in the animal, work springs out of the chemical transformation of material, but in the plant the process is relatively so slow that it must necessarily store up energy, not in the form of chemical compounds capable of producing work by their disintegration, but in the mechanical tension of elastic membranes. The plant-cell uses its material *continually* in tightening springs which it has the power of letting off at any required moment by virtue of that wonderful property of excitability which we have been studying. Animal contractile protoplasm, and particularly that of muscle, does work only when required, and, in doing so, uses its material directly."

Origin of Winding River-Beds.—Major Stevanovics, a Hungarian officer, has published an essay on the laws by which the "wash" and meandering of rivers are regulated. Based on studies of the Theiss and the Danube, the principles he elucidates are illustrated in the windings of rivers the world over, with such variations only as differences in situations and exposures might occasion. The deviations which rivers are constantly making in their course are, it appears, determined by fixed laws, which engineers should be competent to find out and regard. To understand them more fully, we may imagine our river straight, evenly broad and deep, with no marked channel, and without tributaries. The formation of a channel begins as soon as a bit of the earthy constituents contained in the water is deposited on the ground under it. This causes an unequal distribution of the weight of the water, and a stronger inclination toward one or the other edge. The deposit slowly grows, and a sand-bar is formed, which presses the current over toward one side and gives it an angular direction. This causes it to strike with more force against one of the shores, and to wash it, eat it away, or undermine it, equally whether it be of earth or stone. Should there be a tributary coming in from the opposite side of the sand-bar, that will occasion the formation of a second bar, and this will cause the current to make another turn and render its course serpentine. In this way a system of bars is formed, that are represented in the course of time by dry alluvial deposits, from which the river has been constantly pushed to one side. Many of the peculiarities of African and other rivers may be explained by reference to these principles. The great bends of the Congo and the Niger may be accounted for by supposing that the hills that run parallel to their courses were weathered most on the side most exposed to the sun so as to cause a constant growth of the bars on the north side and a gradual pushing of the stream toward the equator. In Hungary, the courses of the streams are modified by the operation of another force, that of the equinoctial winds called the *koschava*, which blow in the spring and fall for days at a time from the southeast. The waves are driven by the wind, especially at the time of high water in the spring, with more force against the western bank, and make longitudinal excavations in it at the level of the water. After the retiring of the flood, the overhanging bank gives way and slides into the river, with a noise which is quite familiar to the people, and well understood by them. These excavations, extended and deepened by subsequent operations of the same kind, result in the formation of large bends; and the river has become very serpentine, with numerous narrow peninsulas jutting out at right angles to its current. Finally, the peninsulas are cut through and formed into islands, to become in time, as has been the case in some instances, by the operation of continued changes of the stream, a part of the other bank. Observations of this kind have been made in the Danube, and the phenomena accounted for by them are familiar on other rivers. Changes by another kind of process are caused by the fall equinoctial winds, which, instead of finding high water in their way, take up the dry sand and deposit it in drifts where they will exercise a modifying influence on the course of the river. The changes that have taken place in the Amou-Darya of Turkistan, under which its course has been diverted from the Caspian Sea to the Sea of Aral, are probably effects of an agency of this kind.

Russian Scientific Societies.—Science is promoted in Russia by several societies that are very active in their respective fields of investigations, and which have earned for their country a respectable place among the nations where knowledge is diligently and intelligently cultivated. The Kiev Society of Naturalists was formed in 1869, and is supported by a considerable membership. Its chief aim has been the exploration of the natural history of the neighboring provinces. Its published "Transactions" bear evidence of good work done in geology, zoölogy, botany, and kindred sciences. Since 1873 it has undertaken the yearly publication of a systematic catalogue of papers in mathematics, pure and applied, natural science, and medicine, printed in the numerous scientific publications of the empire. The East Siberian branch of the Russian Geographical Society, having already contributed largely to the purely geographical exploration of the unknown parts of Siberia and the adjacent countries, has now become engaged upon a more thorough scientific exploration of Siberia itself. Among its later publications is an excellent geological map of the coasts of Lake Baikal. The Siberian branch of the Geographical Society has within the last few years taken a lively interest in anthropology and archæology, and has been the means of making known many valuable discoveries in these branches. It has also paid much attention to the meteorology of Siberia, has taken regular observations at meteorological stations, and has collected materials for ascertaining the dates of the freezing and breaking up of the ice in the rivers of the country.

NOTES.

Concerning the statement that Mr. Herbert Spencer is going around the world by way of Australia and San Francisco, he thus writes to an American friend: "The rumor you indicate respecting my voyage to Australia and New Zealand is all nonsense, as you suspected. Last summer I had a letter from Sir George Gray (late Governor of New Zealand), pressing me to go and stay with him, and promising great benefit to my health. My reply was that the probable result of yielding to his pressure would be that I should be left in mid-Atlantic with a cannon-shot at my feet."

Mr. Charles Dimitry, of New Orleans, some two years ago proposed an hypothesis that the mounds and earthworks in the Western river-bottoms were intended for places of refuge for the people and their stock in time of high water and floods. His theory received some striking illustrations during the recent expedition of the relief-steamer Tensas to the flooded districts of Red River. The water was found rushing through the crevasses with a loud noise. Trinity was completely submerged, and at Troy the situation was but little better. With the exception of a few buildings erected upon mounds (among the largest mounds in the United States), all had succumbed to the water. The graveyard on one of the mounds had become a rendezvous for stock, pigs, sheep, and human beings. At Lamarque, in Concordia Parish, where the water stood six feet deep, the stock were cared for on mounds or in houses.

The American Ornithologists' Union has undertaken to ascertain the true character of the European house-sparrow, which has now become so abundant in this country, and of the effect of its presence upon agricultural and economical interests. It has prepared a circular of inquiries to be sent out to intelligent persons who will undertake the observations, the tenor of the answers to which, it is hoped, will determine whether the bird is eligible or ineligible as a naturalized citizen of our land. The more important of the questions bear chiefly upon the nature of the sparrow's food, the effect of its presence upon useful birds and beneficial as well as deleterious insects, and its effects on shade, fruit, and ornamental trees, and garden fruits and vegetables. Persons interested in the subject may communicate with the chairman of the association's committee, Dr. J. B. Holder, American Museum of Natural History, Central Park, New York city.

Professor John Hutton Balfour, Emeritus Professor of Botany in the University of Edinburgh, died February 11th, in the seventy-seventh year of his age. He was chosen to fill the place of Sir William Hooker, at Glasgow, when Hooker was called from that place to Kew, and was elected to the Regius Professorship of Botany at Edinburgh in 1845. He retired from this position, on account of infirmity, in 1877. He published much, but was better known as a teacher than as an original investigator.

Mr. F. Cope Whitehouse presented to the Academy of Sciences (March 24th) the results of his geological researches and survey of the cañon of the Nile, with especial reference to the Pyramids of Gizeh. He denies that the material was brought from any considerable distance. Geology and tradition show that the two large piles are reconstructed hills. The whole hill has probably been rebuilt, except the lower 180 feet. It seems to have been done by the excavation of a chamber in the center of the mass of soft, horizontal limestone, and the transfer of blocks from the ceiling to the floor until the top of the hill had been reached. Thus a precarious and dangerous mound of poor, clayey limestone was converted into a permanent protection and stable structure without great expense and without disturbing the beautiful edifices of granite and alabaster tanks and tombs whose remains are still found on the terrace and near the Sphinx at its foot.

The death, at the age of forty-eight years, is announced of Richard Cortembert, a French geographer, who until 1878 held a position in the geographical department of the Bibliothèque Nationale. Among his works were "Grands Voyages Contemporains" (1864), ("Great Contemporary Voyages"), and "Geographie Commerciale" ("Commercial Geography") for schools (1868.) At the time of his death he was engaged upon a "New History of Voyages."

The Rev. Dr. J. G. Macvicar, of Moffat, Scotland, who died February 12th, aged eighty-four years, was a diligent student of natural science in early life, and was from 1827 the first lecturer in natural history in the University of St. Andrews. He was editor of the "Quarterly Journal of Agriculture," and was the author of "The Elements of the Economy of Nature" and other scientific books and papers, and of a treatise on "The Philosophy of the Beautiful." His best-known work was "An

Inquiry into Human Nature," which was composed during his residence in Ceylon, from 1840 to 1842.

It has been remarked that the destructive force of a tropical hurricane appears to be greater than the velocity of the wind will account for, when compared with the velocity of an ordinary head gale. Mr. Joseph John Murphy suggests, in the London "Spectator," that the fact may be satisfactorily explained by the law that the pressure, and consequently the destructive force of any current, whether of air or water, is proportional, not to the velocity, but to the square of the velocity; so that, if the velocity is doubled, the destructive force is increased fourfold.

J. F. Julius Schmidt, Director of the Observatory at Athens, Greece, died in that city late in February, aged fifty-eight years. He was a German by birth, and was connected with several observatories in Germany before he was called to Athens in 1858. One of his most important works is his map of the moon, which embodies the results of thirty-five years of work. He investigated the volcanic phenomena at Santorin, and composed a work on volcanoes. He studied earthquakes and the relations of the moon to them, and, in meteorology, he published a study on the duration of the twilight.

Hann, of Vienna, objects to the theory that the eruption of Krakatoa filled the air with dust enough to cause red lights all over the world, on account of the quantity of dust it would take. He calculates that the volume of Krakatoa, supposing it to be 822 metres high and four kilometres in diameter at the base, was 13,780 cubic kilometres. Supposing it all to be reduced to dust and scattered over the earth, it would form a thickness of only three hundredths of a millimetre. At a height of ten miles above the surface, the dust-stratum would be still thinner. Herr Hann does not seem to have taken into consideration the fact that the dust came from the bowels of the earth and not from the volcano alone; and he may not have made sufficient allowance for the extremely attenuated condition in which it was.

An International Forestry Exposition is to be opened this year in Edinburgh. It will be devoted to the exhibition of the forest-products of the whole earth, and will be open to all nations.

Professor Heinrich Carl Berghaus, a distinguished German geographer, cartographer, and historiographer, died in Stettin, February 17th, in his eighty-seventh year. Besides his work on general atlases and many special maps, he was the author of the best map of the Iberian Peninsula, of an atlas of Asia with fifteen maps and text, a physical atlas of ninety-three maps; of numerous important works on geography; of many communications to the German scientific papers and departments; and of a text-book of geography, which, translated into the vernacular languages, is in use in schools in India.

The death of Dr. J. Todhunter, an eminent mathematician and author of text-books, is announced.

Captain Neils Hoffmeyer, Director of the Meteorological Institute of Copenhagen since 1872, has recently died. He was the author of an important paper on the storms of the Northern Atlantic; published for three years a daily synoptical weather-chart; prompted the establishment of meteorological stations in Greenland and Iceland, and was Secretary of the International Polar Commission.

M. Jean Baptiste Dumas, the distinguished French chemist, died April 11th, in the eighty-fourth year of his age. Since 1823 he has been constantly adding to our knowledge of organic chemistry. His theory of substitution and his treatise on chemistry as applied to the arts were important contributions to the science. He has been at different times a member of the National Assembly, Minister of Agriculture and Commerce, and Vice-President of the Senate, of France. In 1868 he became Permanent Secretary of the French Academy of Sciences. A portrait and biographical sketch of M. Dumas were given in vol. xviii, p. 257, of "The Popular Science Monthly" (December, 1880).

Drs. Ferrier and Gerald Yeo communicated a paper to a recent meeting of the Royal Society on the effects of lesions of different regions of the cerebral hemispheres. They described experiments conducted upon monkeys, in which they removed, under anæsthetics, certain limited areas of the cortex; the results of the experiments went to confirm in a very exact manner most of the conclusions previously arrived at by Dr. Ferrier and by neuropathologists. The localization of the centers of sight and hearing and the effect of removing portions of the brain in producing anæsthesia on the opposite side of the body were thus tested.

Dr. Wilson, of England, has tried to count the number of hairs on the human head. Taking a fairly hirsute head, he found the number of hairs on a square inch of surface to be 1,066. This, he estimated, would give 127,920 for the whole head. More thickly-clad heads might have 150,000 hairs.

A correspondent of "Nature" reports an illustration of the power of organization in the mouse. He was waked up one night by a distinct, continuous grinding under the floor of his room, which lasted till after daylight, when it suddenly ceased, and the room seemed in an instant filled with mice. One of the mice caught on a bell-pull, and climbed upon it to near the ceiling. Then he "turned himself round, and for a few minutes quietly surveyed the room; then deliberately descended, and in two or three minutes not a mouse was left in the room." The correspondent supposes that this scout-mouse was the chief-engineer of the company, and had directed the siege-operations; that he rose to an eminent point to survey the conquest, and that, finding it contained nothing of interest to mice, gave the word to his followers, after which they all retired.

According to an essay by Dr. D. J. Macgowan, China has no copyright law, but authors' rights are protected with certainty, upon the theory that their writings are as really property as their material goods, and are so obviously so that no particular designation is required. These rights are hereditary, and not limited. Authors do not make arrangements with publishers; that would be undignified. They have their books cut and printed on their own premises, and then sell them to the trade. Ephemeral books are, however, sold to publishers, and are then liable to be pirated. The book-trade has only the most limited facilities for advertising and circulating its issues; yet, the knowledge of new publications is very quickly spread through the country, and the books get to all interested in them in a remarkably short time.

M. Joseph Lecornu has suggested several ways in which balloons might be used in astronomical research. The appearance of heavenly bodies near the horizon is distorted by refraction. We can not make exact allowances for the distortion, because we have no rule by which to measure the rate of atmospheric refraction, and learn the laws under which it varies. With balloons we might sound the air in all weathers, and in time get a rule. Balloons also could take us above the clouds and atmospheric hazes, and enable us to get direct views of eclipses, transits, comets, and meteoric showers when they might be obscured at the surface, and of such phenomena as the aurora borealis and the zodiacal light that are always observed at the surface under difficulties. M. de Fonvielle has already made satisfactory observations and measurements of a comet and observations of shooting-stars, from a balloon.

An Italian ship has been sheathed with glass instead of copper. The plates are cast like iron plates to fit the hull of the vessel, and are made water-tight by means of a silicate mastic. They are claimed to be exempt from the vices of oxidation and incrustation.

M. Wroblesky has succeeded in liquefying oxygen in considerable quantities, and then, by removing the pressure, allowing it to boil. By this means he has produced a cold of —186°C., or —302·8° Fahr., at which nitrogen has become solidified into a snow composed of crystals "of a remarkable dimension." M. Wroblesky announces that he has obtained the liquefaction of hydrogen, by exposing it to the cooling influence of liquid oxygen at the instant of evaporation.

A conflict of opinion having broken out between the Municipal Council of Paris and the gas company, as to what the price of gas should be, a scientific commission has been appointed to decide whether the gas industry has so advanced as to justify a diminution in the price.

M. F. Terby states, in the "Bulletin" of the Belgian Academy of Sciences, that he believes he has found a monthly period for the aurora borealis, corresponding with the returning presentation, every twenty-seven days, of the same sun-spots to the earth.

M. Cornu lately described to the French Academy of Sciences a white rainbow which he saw on the morning of the 28th of November. There had been a heavy hoar-frost, followed by a thick, low fog. This rainbow was wholly white, without even as much iridization as is noticeable in halos, and had a fleecy appearance like that of the fumes of phosphureted hydrogen, or the smoke from the mouth of a cannon.

The detonations of the recent earthquake in the Straits of Sunda were distinctly heard through all the Philippine Islands—so distinctly that some persons thought a battle was going on, or that some vessel was firing signals of distress.

The savages of the Maclay coast of New Guinea, according to Dr. Miclucho-Maclay, seldom bury their dead. As soon as a man dies, his body is placed in a sitting posture and covered with palm-leaves. It is then exposed to the fire for two or three weeks, till it becomes wasted away or dried up. The bodies of children are simply hung up to decay in a basket under the roof. Burial is rarely given, except when an old man has survived all his wives and children, and it is then accompanied by numerous ceremonies.

AVERROE, Filosofo Arabo Aristotelico, discepolo d'Avicenna, autore di molti Trattati di Filosofia, e di Medicina, fiorì nel Secolo dodicesimo di Gesù Cristo   di Raffaello nel Vaticano   P. Fidanza del. ed inc.

AVERROËS.

THE

POPULAR SCIENCE MONTHLY.

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THE GREAT POLITICAL SUPERSTITION.

By HERBERT SPENCER.

THE great political superstition of the past was the divine right of kings. The great political superstition of the present is the divine right of parliaments. The oil of anointing seems unaware to have dripped from the head of the one on to the heads of the many, and given sacredness to them also and to their decrees.

However irrational we may think the earlier of these beliefs, we must admit that it was more consistent than is the latter. Whether we go back to times when the king was a god, or to times when he was a descendant of a god, or to times when he was god-appointed, we see valid reason for passive obedience to his will. When, as under Louis XIV, theologians like Bossuet taught that kings "are gods, and share in a manner the Divine independence," or when it was thought, as by our own Tory party in old days, that "the monarch was the delegate of heaven," it is clear that, given the premise, the inevitable conclusion was that no bounds could be set to governmental commands. But for the modern belief, such a warrant does not exist. Making no pretension to divine descent or divine appointment, a legislative body can show no supernatural justification for its claim to unlimited authority; and no natural justification has ever been attempted. Hence, belief in its unlimited authority is without that consistency which of old characterized belief in a king's unlimited authority.

It is curious how commonly men continue to hold in fact, doctrines which they have rejected in name—retaining the substance after they have abandoned the form. In Theology an illustration is supplied by Carlyle, who, in his student-days, giving up, as he thought, the creed of his fathers, rejected its shell only, and kept the contents—was proved by his conceptions of the world, and man, and conduct, to be still among the sternest of Scotch Calvinists. Similarly, Science furnishes an instance in one who united naturalism in Geology with supernaturalism in Biology—Sir Charles Lyell. While, as the leading expositor of the uniformitarian theory in geology, he ignored wholly the Mosaic cosmogony, he long defended that belief in special creations of organic types, for which no other source than the Mosaic cosmogony could be assigned; and only in the latter part of his life surrendered to the arguments of Mr. Darwin. In Politics, as above implied, we have an analogous case. The tacitly-asserted doctrine, common to Tories, Whigs, and Radicals, that governmental authority is unlimited, dates back to times when the lawgiver was supposed to have a warrant from God; and it survives still, though the belief that the lawgiver has God's warrant has died out. "Oh, an Act of Parliament can do anything," is the reply made to a citizen who questions the legitimacy of some arbitrary state interference; and the citizen stands paralyzed. It does not occur to him to ask the how, and the when, and the whence, came this asserted omnipotence, bounded only by physical impossibilities.

Here we will take leave to question it. In default of the justification, once logically valid, that the ruler on Earth being a deputy of the ruler in Heaven, submission to him in all things is a duty, let us ask what reason there is for asserting the duty of submission in all things to a ruling power, constitutional or republican, which has no heaven-derived supremacy. Evidently this inquiry commits us to a criticism of past and present theories concerning political authority. To revive questions supposed to be long since settled, may be thought to need some apology; but there is a sufficient apology in the implication above made clear, that the theory commonly accepted is ill-based or unbased.

The notion of sovereignty is that which first presents itself; and a critical examination of this notion, as entertained by those who do not postulate the supernatural origin of sovereignty, carries us back to the arguments of Hobbes.

Let us grant Hobbes's postulate that, "during the time men live without a common power to keep them all in awe, they are in that condition which is called war . . . of every man against every man"; * though this is not true, since there are some small societies in which, without any "common power to keep them all in awe," men maintain peace and harmony better than it is maintained in societies where such a power exists. Let us suppose him to be right, too, in assuming that the rise of a common ruling power over associated men, results from their desires to preserve order among themselves; though, in fact, it habitually arises from the need for subordination to a leader in war,

* Hobbes's "Collected Works," vol. iii, pp. 112, 113.

defensive or offensive, and has originally no necessary, and often no actual, relation to the preservation of order among the combined individuals. Once more, let us admit the indefensible assumption that to escape the evils of chronic warfare, which must otherwise continue among them, the members of a community enter into a "pact or covenant," by which they all bind themselves to surrender their primitive freedom of action, and subordinate themselves to the will of a ruling power agreed upon;* accepting, also, the implication that their descendants forever are bound by that covenant which their great-great-great, etc., grandfathers made for them. Let us, I say, not object to these data, but pass to the conclusions Hobbes draws. He says:

> For, where no covenant hath preceded, there hath no right been transferred, and every man has right to every thing; and, consequently, no action can be unjust. But when a covenant is made, then to break it is *unjust*, and the definition of INJUSTICE is no other than *the not performance of covenant*. . . . Therefore, before the names of just and unjust can have place, there must be some coercive power to compel men equally to the performance of their covenants by the terror of some punishment greater than the benefit they expect by the breach of their covenant.†

Were people's characters in Hobbes's day really so bad as to warrant his assumption that none would perform their covenants in the absence of a coercive power and threatened penalties? In our day "the names of just and unjust can have place" quite apart from recognition of any coercive power. Among my friends I could name half a dozen whom I would implicitly trust to perform their covenants without any "terror of some punishment"; and over whom the requirements of justice would be as imperative in the absence of a coercive power as in its presence. Merely noting, however, that this unwarranted assumption vitiates Hobbes's argument for State-authority, and accepting both his premises and conclusion, we have to observe two significant implications. One is that State-authority, as thus derived, is a means to an end, and has no validity, save as subserving that end: if the end is not subserved, the authority, by the hypothesis, does not exist. The other is, that the end for which the authority exists, as thus specified, is the enforcement of justice—the maintenance of equitable relations. The reasoning yields no warrant for other coercion over citizens than that which is required for preventing direct aggressions, and those indirect aggressions constituted by breaches of contract; to which, if we add protection against external enemies, the entire function implied by Hobbes's derivation of sovereign authority is comprehended.

Hobbes argued in the interests of absolute monarchy. His modern admirer, Austin, had for his aim to derive the authority of law from the unlimited sovereignty of one man, or of a number of men, small

* Hobbes's "Collected Works," vol. iii, p. 159.

† Ibid., pp. 130, 131.

or large, compared with the whole community. Austin was originally in the army; and it has been truly remarked that "the permanent traces left" may be seen in his "Province of Jurisprudence." When, undeterred by the exasperating pedantries—the endless distinctions and definitions and repetitions—which serve but to hide his essential doctrines, we ascertain what these are, it becomes manifest that he assimilates civil authority to military authority: taking for granted that the one, as the other, is above question in respect of both origin and range. To get justification for positive law, he takes us back to the absolute sovereignty of the power imposing it—a monarch, an aristocracy, or that larger body of men who have votes in a democracy; which body he also styles the sovereign, in contrast with the remaining portion of the community, which, from incapacity or other cause, remains subject. And having affirmed, or rather taken for granted, the unlimited authority of the body, simple or compound, small or large, which he styles sovereign, he, of course, has no difficulty in deducing the validity of its edicts, which he calls positive law. But the problem is simply moved a step further back, and there left unsolved. The true question is, Whence the sovereignty? What is the assignable warrant for this unqualified supremacy assumed by one, or by a small number, or by a large number, over the rest? A critic might fitly say—"We will dispense with your process of deriving positive law from unlimited sovereignty: the sequence is obvious enough. But first prove your unlimited sovereignty."

To this demand there is no response. Analyze his assumption, and the doctrine of Austin proves to have no better basis than that of Hobbes. In the absence of admitted divine descent or appointment, neither single-headed ruler nor many-headed ruler can produce such credentials as the claim to unlimited sovereignty implies.

"But surely," will come in deafening chorus the reply, "there is the unquestionable right of the majority, which gives unquestionable right to the parliament it elects."

Yes, now we are coming down to the root of the matter. The divine right of Parliaments means the divine right of majorities. The fundamental assumption made by legislators and people alike is that a majority has powers to which no limits can be put. This is the current theory which all accept, without proof, as a self-evident truth. Nevertheless, criticism will, I think, show that this current theory requires a radical modification.

In an essay on "Railway Morals and Railway Policy," published in the "Edinburgh Review," for October, 1854, I had occasion to deal with the question of a majority's powers, as exemplified in the conduct of public companies; and I can not better prepare the way for conclusions presently to be drawn than by quoting some passages from it:

Under whatever circumstance, or for whatever ends, a number of men co-operate, it is held that if difference of opinion arises among them, justice requires that the will of the greater number shall be executed rather than that of the smaller number; and this rule is supposed to be uniformly applicable, be the question at issue what it may. So confirmed is this conviction, and so little have the ethics of the matter been considered, that to most this mere suggestion of a doubt will cause some astonishment. Yet it needs but a brief analysis to show that the opinion is little better than a political superstition. Instances may readily be selected, which prove, by *reductio ad absurdum*, that the right of a majority is a purely conditional right, valid only within specific limits. Let us take a few. Suppose that at the general meeting of some philanthropic association it was resolved that, in addition to relieving distress, the association should employ home missionaries to preach down popery. Might the subscriptions of Catholics, who had joined the body with charitable views, be rightfully used for this end? Suppose that of the members of a book-club the greater number, thinking that, under existing circumstances, rifle-practice was more important than reading, should decide to change the purpose of their union, and to apply the funds in hand for the purchase of powder, ball, and targets. Would the rest be bound by this decision? Suppose that, under the excitement of news from Australia, the majority of a Freehold Land Society should determine, not simply to start in a body for the gold-diggings, but to use their accumulated capital to provide outfits. Would this appropriation of property be just to the minority? and must these join the expedition? Scarcely any one would venture an affirmative answer even to the first of these questions, much less to the others. And why? Because every one must perceive that by uniting himself with others, no man can equitably be betrayed into acts utterly foreign to the purpose for which he joined them. Each of these supposed minorities would properly reply to those seeking to coerce them: "We combined with you for a defined object; we gave money and time for the furtherance of that object; on all questions thence arising we tacitly agreed to conform to the will of the greater number; but we did not agree to conform on any other questions. If you induce us to join you by professing a certain end, and then undertake some other end of which we were not apprised, you obtain our support under false pretenses: you exceed the expressed or understood compact to which we committed ourselves; and we are no longer bound by your decisions." Clearly this is the only rational interpretation of the matter. The general principle underlying the right government of every incorporated body is, that its members contract with each other severally to submit to the will of the majority in all matters concerning the fulfillment of the objects for which they are incorporated; but in no others. To this extent only can the contract hold. For as it is implied in the very nature of a contract that those entering into it must know what they contract to do, and as those who unite with others for a specified object can not contemplate all the unspecified objects which it is hypothetically possible for the union to undertake, it follows that the contract entered into can not extend to such unspecified objects; and if there exists no expressed or understood contract between the union and its members respecting unspecified objects, then for the majority to coerce the minority into undertaking them is nothing less than gross tyranny.

Naturally, if such a confusion of ideas exists in respect of the powers of a majority where the deed of incorporation tacitly limits those powers, still more is there likely to exist such a confusion where there has been no such deed of incorporation. But the same principle holds. I again emphasize the proposition that the members of an incorporated body are bound "severally to submit to the will of the majority *in all matters concerning the fulfillment of the objects for which they are incorporated, but in no others.* And I contend that this holds of an incorporated nation as much as of an incorporated company.

"Yes, but," comes the obvious rejoinder, "as there is no deed by which the members of a nation are incorporated—as there neither is, nor ever was, a specification of purposes for which the union was formed, there exist no limits; and, consequently, the power of the majority is unlimited."

Evidently it must be admitted that the hypothesis of a social contract, either under the shape assumed by Hobbes, or under the shape assumed by Rousseau, is baseless. Nay, more, it must be admitted that even had such a contract once been formed, it could not be binding on the posterity of those who formed it. Moreover, if any say that in the absence of those limitations to its powers which a deed of incorporation might imply, there is nothing to prevent a majority from imposing its will on a minority by force, assent must be given—an assent, however, joined with the comment that if the superior force of the majority is its justification, then the superior force of a despot backed by an adequate army, is also justified: the problem lapses. What we here seek is some higher warrant for the subordination of minority to majority than that arising from inability to resist physical coercion. Even Austin, anxious as he is to establish the unquestionable authority of positive law, and assuming, as he does, an absolute sovereignty of some kind, monarchic, aristocratic, constitutional, or popular, as the source of its unquestionable authority, is obliged, in the last resort, to admit a moral limit to its action over the community. While insisting, in pursuance of his rigid theory of sovereignty, that a sovereign body originating from the people "is *legally* free to abridge their political liberty at its own pleasure or discretion," he allows that "a government may be hindered by *positive morality* from abridging the political liberty which it leaves or grants to its subjects."* Hence, we have to find, not a physical justification, but a moral justification, for the supposed absolute power of the majority.

This will at once draw forth the rejoinder, "Of course, in the absence of any agreement, with its implied limitations, the rule of the majority is unlimited; because it is more just that the majority should have its way than that the minority should have its way." A very reasonable rejoinder this seems until there comes the re-rejoinder. We may oppose to it the equally tenable proposition that, in the absence of an agreement, the supremacy of a majority over a minority does not exist at all. It is co-operation of some kind, from which there arise

* "The Province of Jurisprudence Determined" (second edition), p. 241.

these powers and obligations of majority and minority; and, in the absence of any agreement to co-operate, such powers and obligations are also absent.

Here the argument apparently ends in a dead-lock. Under the existing condition of things no moral origin seems assignable either for the sovereignty of the majority or for the limitation of its sovereignty. But further consideration reveals a solution of the difficulty. For if, dismissing all thought of any hypothetical agreement to co-operate heretofore made, we ask, what would be the agreement into which citizens would now enter with practical unanimity, we get a sufficiently clear answer; and with it a sufficiently clear justification for the rule of the majority inside a certain sphere, but not outside that sphere. Let us first observe a few of the limitations which at once become apparent.

Were all Englishmen now asked if they would agree to co-operate for the teaching of religion, and would give the majority power to fix the creed and the forms of worship, there would come a very emphatic "No" from a large part of them. If, in pursuance of a proposal to revive sumptuary laws, the inquiry were made whether they would bind themselves to abide by the will of the majority in respect of the fashions and qualities of their clothes, nearly all of them would refuse. In like manner, if (to take an actual question of the day) people were polled to ascertain whether, in respect of the beverages they drank, they would accept the decision of the greater number, half, and probably more than half, would very decidedly decline. Similarly with respect to many other actions which most men now-a-days regard as of purely private concern. Whatever desire there might be to co-operate for carrying on, or regulating, such actions, would be far from a unanimous desire. Manifestly, then, had social co-operation to be commenced by ourselves, and had its purposes to be specified before consent to co-operate could be obtained, there would be large parts of human conduct in respect of which co-operation would be declined; and in respect of which, consequently, no authority by the majority over the minority could be rightfully exercised.

Turn now to the converse question, For what ends would all men agree to co-operate? None will deny that for resisting invasion the agreement would be practically unanimous. Excepting only the Quakers, who, having done highly useful work in their time, are now dying out, all would unite for defensive war (not, however, for offensive war); and they would, by so doing, tacitly bind themselves to conform to the will of the majority in respect of measures directed to that end. There would be practical unanimity, also, in the agreement to co-operate for defense against internal enemies as against external enemies. Omitting criminals, all must wish to have person and property adequately protected. In short, each citizen desires to preserve his life, to preserve those material things which conduce to maintenance of his life, and to preserve intact his powers both of using these material things and getting further such. It is obvious to him that he can not do this if he acts alone. Against foreign invaders he is powerless unless he combines with his fellows; and the business of protecting himself against domestic invaders if he did not similarly combine, would be alike onerous, dangerous, and inefficient. That is to say, in respect of all measures for maintaining those conditions under which only the business of life can be carried on and its satisfactions obtained, every one will agree to co-operate; and, by implication, will agree to submit to the majority on all questions thence arising.

Details are not needful here; nor is it needful to discuss that border region lying between these classes of cases, and to say how much is included in the last and how much is excluded with the first. For the present purpose, it is sufficient to recognize the undeniable truth that there are numerous kinds of actions in respect of which men would not, if they were asked, agree with anything like unanimity to be bound by the will of the majority; while there are some kinds of actions in respect of which they would almost unanimously agree to be thus bound. Here, then, we find a definite warrant for enforcing the will of the majority within certain limits, and a definite warrant for denying the authority of its will beyond those limits.

But evidently, when analyzed, the question resolves itself into the further question, What are the relative claims of the aggregate and of its units? Are the rights of the community universally valid against the individual? or has the individual some rights which are valid against the community? The judgment given on this point underlies the entire fabric of political convictions formed, and more especially those convictions which concern the proper sphere of government. Here, then, I propose to revive a dormant controversy, with the expectation of reaching a different conclusion from that which is fashionable.

Says Professor Jevons, in his work, "The State in Relation to Labor"—"The first step must be to rid our minds of the idea that there are any such things in social matters as abstract rights." Of like character is the belief expressed by Mr. Matthew Arnold, in his article on copyright: "An author has no natural right to a property in his production. But then neither has he a natural right to anything whatever which he may produce or acquire." * So, too, I recently read in a weekly journal of high repute, that "to explain once more that there is no such thing as 'natural right' would be a waste of philosophy." And the view expressed in these extracts is commonly uttered by statesmen and lawyers in a way implying that only the unthinking masses hold any other.

* "Fortnightly Review," in 1880, vol. xxvii, p. 322.

One might have expected that utterances to this effect would have been rendered less dogmatic by the knowledge that a whole school of legists on the Continent maintains a belief diametrically opposed to that maintained by the English school. The idea of *Natur-recht* is the root-idea of German jurisprudence. Now, whatever may be the opinion held respecting German philosophy at large, it can not be characterized as shallow. A doctrine current among a people distinguished above all others as laborious inquirers, and certainly not to be classed with superficial thinkers, should not be dismissed as though it were nothing more than a popular delusion. This, however, by the way. Along with the proposition denied in the above quotations, there goes a counter-proposition affirmed. Let us see what it is, and what results when we go behind it and seek its warrant.

On reverting to Bentham, we find this counter-proposition overtly expressed. He tells us that government fulfills its office "by creating rights, which it confers upon individuals—rights of personal security; rights of protection for honor; rights of property"; etc.* Were this doctrine asserted as following from the divine right of kings, there would be nothing in it manifestly incongruous. Did it come to us from ancient Peru, where the Inca "was the source from which everything flowed"; † or from Shoa (Abyssinia), where "of their persons and worldly substance he [the king] is absolute master"; ‡ or from Dahome, where "all men are slaves to the king"; # it would be consistent enough. But Bentham, far from being an absolutist like Hobbes, wrote in the interests of popular rule. In his "Constitutional Code" ‖ he fixes the sovereignty in the whole people: arguing that it is best to "give the sovereign power to the largest possible portion of those whose greatest happiness is the proper and chosen object," because "this proportion is more apt than any other that can be proposed" for achievement of that object.

Mark, now, what happens when we put these two doctrines together. The sovereign people is to appoint representatives, and so to create a government; the government thus created, creates rights; and then, having created these rights, it confers them on the sovereign people by which it was itself created. Here is a marvelous piece of political legerdemain! Mr. Matthew Arnold, contending, in the article above quoted, that "property is the creation of law," tells us to beware of the "metaphysical phantom of property in itself." Surely, among metaphysical phantoms the most shadowy is this which supposes a thing to be obtained by creating an agent, which creates the thing, and then confers the thing on its own creator!

* Bentham's Works (Bowring's edition), vol. i, p. 301.

† Prescott, "Conquest of Peru," book i, ch. i.

‡ Harris, "Highlands of Æthiopia," ii, 94.

\# Burton, "Mission to Gelele, King of Dahomie," i, p. 226.

‖ Bentham's Works, vol. ix, p. 97.

From whatever point of view we consider it, Bentham's proposition proves to be unthinkable. Government, he says, fulfills its office "by creating rights." Two meanings may be given to the word "creating." It may be supposed to mean the production of something out of nothing; or it may be supposed to mean the giving form and structure to something which already exists. There are many who think the production of something out of nothing can not be conceived as effected even by Omnipotence; and probably none will assert that the production of something out of nothing is within the competence of a human government. The alternative conception is that such human government creates only in the sense that it shapes something pre-existing. In that case, the question arises, "What is the something pre-existing which it shapes?" Clearly the word "creating" begs the whole question—passes off an illusion upon the unwary reader. Bentham was a stickler for definiteness of expression, and in his "Book of Fallacies" has a chapter on "Impostor-terms." It is curious that he should have furnished so striking an illustration of the perverted belief which an impostor-term may generate.

But now let us overlook these various impossibilities of thought, and seek the most defensible interpretation of Bentham's view.

It may be said that the totality of all possessions, powers, rights, originally existed as an undivided whole in the sovereign people; and that this undivided whole is given in trust (as Austin would say) to a ruling power, appointed by the sovereign people, for the purpose of distribution. If, as we have seen, the proposition that rights are created is simply a figure of speech, then the only intelligible construction of Bentham's view is that a multitude of individuals, who severally wish to satisfy their desires, and have, as an aggregate, possession of all the sources of satisfaction, as well as power over all individual actions, appoint a government, which declares the ways in which, and the conditions under which, individual actions may be carried on and the satisfactions obtained. Let us observe what are the implications. Each man exists in two capacities. In his private capacity he is subject to the government. In his public capacity he is one of the sovereign people who appoint the government. That is to say, in his private capacity he is one of those to whom rights are given; and in his public capacity he is one of those who, through their agency, give the rights. Turn this abstract statement into a concrete statement, and see what it means. Let the community consist of a million men, who, by the hypothesis, are not only joint possessors of the inhabited region, but joint possessors of all liberties of action and appropriation: the only right recognized being that of the aggregate to everything. What follows? Each person, while not owning any product of his own labor, has, as a unit in the sovereign body, a millionth part of the ownership of the products of all others' labor. This is an unavoidable implication. No body of men can confer that which it has not got. As the government, in Bentham's view, is but an agent, the rights it confers are rights given to it in trust by the sovereign people. If so, such rights must be possessed *en bloc* by the sovereign people before the government, in fulfillment of its trust, confers them on individuals; and, if so, each individual has a millionth portion of these rights in his public capacity, while he has no rights in his private capacity. These he gets only when all the rest of the million join to endow him with them; while he joins to endow with them every other member of the million!

Thus, in whatever way we interpret it, Bentham's proposition leaves us in a plexus of absurdities.

Even though ignoring the opposite opinion of the German writers on jurisprudence, and even without an analysis which proves their own opinion to be untenable, Bentham's disciples might have been led to treat less cavalierly the doctrine of natural rights. For sundry groups of social phenomena unite to prove that this doctrine is well warranted, and the doctrine they set against it entirely unwarranted.

Tribes in various parts of the world show us that before definite government arises, conduct is regulated by customs. The Bechuanas are controlled by "long-acknowledged customs." * Among the Koranna Hottentots, who only "tolerate their chiefs rather than obey them," † "when ancient usages are not in the way, every man seems to act as is right in his own eyes." ‡ The Araucanians are guided by "nothing more than primordial usages or tacit conventions." # Among the Kirghizes the judgments of the elders are based on "universally-recognized customs." ‖ So, too, of the Dyaks, Rajah Brooke tells us that "custom seems simply to have become the law; and breaking custom leads to a fine." ^ So sacred are immemorial customs with the primitive man, that he never dreams of questioning their authority; and when government arises, its power is limited by them. In Madagascar the king's word suffices only "where there is no law, custom, or precedent." ◊ Raffles tells us that in Java "the customs of the country" ‡ restrain the will of the ruler. In Sumatra, too, the people do not allow their chiefs to "alter their ancient usages." ↕ Nay, occasionally, as in Ashantee, "the atttempt to change some customs" has caused a king's dethronement. ‡ Now, among the customs which we

* Burchell, W. J., "Travels into the Interior of Southern Africa," vol. i, p. 544.

† Arbousset and Daumas, "Voyage of Exploration," p. 27.

‡ Thompson, G., "Travels and Adventures in Southern Africa," vol. ii, p. 30.

\# Thompson, G. A., "Alcedo's Geographical and Historical Dictionary of America," vol. i, p. 405.

‖ Mitchell, Alex., "Siberian Overland Route," p. 248.

^ Brooke's, C., "Ten Years in Saráwak," vol. i, p. 129.

◊ Ellis, "History of Madagascar," vol. i, p. 377.

‡ Raffles, Sir T. S., "History of Java," i, 274.

↕ Marsden, W., "History of Sumatra," p. 217.

‡ Beecham, J., "Ashantee and the Gold Coast," p. 90.

thus find to be pre-governmental, and which subordinate governmental power when it is established, are those which recognize certain individual rights—rights to act in certain ways, and possess certain things. Even where the recognition of property is least developed, there is proprietorship of weapons, tools, and personal ornaments; and, generally, the recognition goes far beyond this. Among such North-American Indians as the Snakes, who are without government, there is private ownership of horses. By the Chippewayans, who have no regular government," game taken in private traps "is considered as private property." * Kindred facts concerning huts, utensils, and other personal belongings, might be brought in evidence from accounts of the Ahts, the Comanches, the Esquimaux, and the Brazilian Indians. Among various uncivilized peoples, custom has established the claim to the crop grown on a cleared plot of land, though not to the land itself; and the Todas, who are wholly without political organization, make a like distinction between ownership of cattle and of land. Kolff's statement respecting "the peaceful Arafuras" well sums up the evidence. They "recognize the right of property in the fullest sense of the word, without there being any authority among them but the decisions of their elders according to the customs of their forefathers." † But even without seeking proofs among the uncivilized, sufficient proofs are furnished by early stages of the civilized. Bentham and his followers seem to have forgotten that our own common law is mainly an embodiment of "the customs of the realm." It did but give definite shape to that which it found existing. Thus, the fact and the fiction are exactly opposite to what they allege. The fact is that property was well recognized before law existed; the fiction is that "property is the creation of law."

Considerations of another class might alone have led them to pause had they duly considered their meanings. Were it true, as alleged by Bentham, that Government fulfills its office "by creating rights which it confers on individuals"; then, the implication would be that there should be nothing approaching to uniformity in the rights conferred by different governments. In the absence of a determining cause overruling their decisions, the probabilities would be many to one against considerable correspondence among their decisions. But there is very great correspondence. Look where we may, we find that governments interdict the same kinds of aggressions; and, by implication, recognize the same kinds of claims. They habitually forbid homicide, theft, adultery: thus asserting that citizens may not be trespassed against in certain ways. And as society advances, minor individual claims are protected by giving remedies for breach of contract, libel, false witness, etc. In a word, comparisons show that though codes of law differ in their details as they become elaborated, they agree in

* Schoolcraft, H. R., "Expedition to the Sources of the Mississippi River," v, 177.

† Earl's "Kolff's Voyage of the Domga," p. 161.

their fundamentals. What does this prove? It can not be by chance that they thus agree. They agree because the alleged creating of rights was nothing else than giving formal sanction and better definition to those assertions of claims and recognitions of claims which naturally originate from the individual desires of men who have to live in presence of one another.

Comparative sociology discloses another group of facts having the same implication. Along with social progress it becomes in an increasing degree the business of the State, not only to give formal sanction to men's rights, but also to defend them against aggressors. Before permanent government exists, and in many cases after it is considerably developed, the rights of each individual are asserted and maintained by himself, or by his family. Alike among savage tribes at present, among civilized peoples in the past, and even now in unsettled parts of Europe, the punishment for murder is a matter of private concern: "the sacred duty of blood revenge" devolves on some one of a cluster of relatives. Similarly, compensations for aggressions on property, and for injuries of other kinds, are in early states of society obtained by each man for himself. But as social organization advances, the central ruling power undertakes more and more to secure to individuals their personal safety, the safety of their possessions, and, to some extent, the enforcement of their claims established by contract. Originally concerned almost exclusively with defense of the society as a whole against other societies, or with conducting its attacks on other societies, Government has come more and more to discharge the function of defending individuals against one another. It needs but to recall the days when men habitually carried weapons, or to bear in mind the greater safety to person and property achieved by improved police-administration during our own time, or to note the increased facilities now given for recovering small debts, to see that the securing to each individual the unhindered pursuit of the objects of life within limits set by others' like pursuits, is more and more recognized as a duty of the State. In other words, along with social progress there goes not only a fuller recognition of these which we call natural rights, but also a better enforcement of them by Government: Government becomes more and more the servant to these essential requirements.

An allied and still more significant change has accompanied this. In early stages, at the same time that the State failed to protect the individual against aggression, it was itself an aggressor in multitudinous ways. Those ancient societies which progressed enough to leave records, having all been conquering societies, show us everywhere the traits of the militant *régime*. As, for the effectual organization of fighting bodies, the soldiers, absolutely obedient, must show no personal independence; so, for the effectual organization of fighting societies, citizens must have their individualities subordinated. Private claims are overridden by public claims, and the subject loses that freedom of action which he had in the primitive state. One result is that the system of regimentation pervading the society as well as the army causes detailed regulation of conduct. The dictates of the ruler, sanctified by ascription of them to his divine ancestor, are unrestrained by any conception of individual liberty; and they specify men's actions to an unlimited extent—down to kinds of food eaten, modes of preparing them, shaping of beards, fringing of dresses, sowing of grain, etc. The omnipresent control, which the ancient eastern nations in general exhibited, was exhibited also in large measure by the Greeks; and was carried to its greatest pitch in the most militant city, Sparta. Similarly during mediæval days throughout Europe, characterized by chronic warfare with its appropriate political forms and ideas, there were no recognized bounds to Governmental interference: agriculture, manufacture, trade, were regulated in detail; religious beliefs and observances were imposed; and rulers said by whom only furs might be worn, silver used, books issued, pigeons kept, etc., etc. But along with increase of industrial activities, and implied substitution of the *régime* of contract for the *régime* of status, and growth of associated sentiments, there went (until the recent reaction accompanying reversion to militant activity) a decrease of meddling with people's doings. Legislation gradually ceased to regulate the cropping of fields, or dictate the ratio of cattle to acreage, or specify modes of manufacture and materials to be used, or fix wages and prices, or interfere with dresses and games (except where there was gambling), or put bounties and penalties on imports or exports, or prescribe men's beliefs, religious or political, or prevent them from combining as they pleased, or traveling where they liked. That is to say, throughout a large range of conduct, the right of the citizen to uncontrolled action has been made good against the pretensions of the State to control him. While the ruling agency has increasingly helped him to exclude intruders from that private sphere in which he pursues the objects of life, it has itself retreated from that sphere; or, in other words—decreased its intrusions.

Not even yet have we noted all the classes of facts which tell the same story. It is told afresh in the improvements and reforms of law itself, as well as in the admissions and assertions of those who have effected them. "So early as the fifteenth century," says Professor Pollock, "we find a common-law judge declaring that, as in a case unprovided for by known rules, the civilians and canonists devise a new rule according to 'the law of nature, which is the ground of all laws,' the Courts of Westminster can and will do the like."* Again, our system of equity, introduced and developed as it was to make up for the shortcomings of Common-law, or rectify its inequities, proceeded

* "The Methods of Jurisprudence: an Introductory Lecture at University College, London," October 31, 1882.

throughout on a recognition of men's claims considered as existing apart from legal warrant. And the changes of law now from time to time made after resistance, are similarly made in pursuance of current ideas concerning the requirements of justice; which, instead of being derived from the law are opposed to the law. For example, that recent Act which gives to a married woman a right of property in her own earnings, evidently originated in the consciousness that the natural connection between labor expended and benefit enjoyed, is one which should be maintained in all cases. The reformed law did not create the right, but recognition of the right created the reformed law.

Thus, historical evidences of five different kinds, unite in teaching that, confused as are the popular notions concerning rights, and including, as they do, much which should be excluded, yet they shadow forth a truth.

Let us now go on to consider the original source of this truth. In a previous paper I have spoken of the open secret, that there can be no social phenomena but what, if we analyze them to the bottom, bring us down to the laws of life; and that there can be no true understanding of them without reference to the laws of life. Let us now change the venue, and transfer this question of natural rights from the court of politics to the court of science—the science of life. The reader need feel no alarm; its simplest and most obvious facts will suffice. Let us contemplate first the general conditions to individual life; and then the general conditions to social life. We shall find that both yield the same verdict.

Animal life involves waste; waste must be met by repair; repair implies nutrition. Again, nutrition presupposes obtainment of food; food can not be got without powers of prehension, and, usually, of locomotion; and that these powers may achieve their ends, there must be freedom to move about. If you shut up a mammal in a small space, or tie its limbs together, or take from it the food it has procured, you eventually, by persistence in one or other of these courses, cause its death. Passing a certain point, hindrance to the fulfillment of these requirements is fatal. And all this, which holds of the higher animals at large, of course holds of man.

If we adopt pessimism as a creed, and with it accept the implication that life in general being an evil should be put an end to, then there is no ethical warrant for these actions by which life is maintained: the whole question drops. But if we adopt either the optimist view or the meliorist view—if we say that life on the whole brings more pleasure than pain; or that it is on the way to become such that it will yield more pleasure than pain; then these actions by which life is maintained are justified, and there results a warrant for the freedom to perform them. Those who hold that life is valuable, hold, by implication, that men ought not to be prevented from carrying on life-sustaining activities. In other words, if it is said to be "right" that they should carry them on, then, by permutation, we get the assertion that they "have a right" to carry them on. Clearly the conception of "natural rights" originates in recognition of the truth that if life is justifiable, there must be a justification for the performance of acts essential to its preservation; and, therefore, a justification for those liberties and claims which make these acts possible.

But being true of other creatures as of man, this is a proposition lacking ethical character. Ethical character arises only with the distinction between what the individual *may* do in carrying on his life-sustaining activities, and what he *may not* do. This distinction obviously results from the presence of his fellows. Among those who are in close proximity, or even at some distance apart, the doings of each are apt to interfere with the doings of others, and in the absence of proof that some may do what they will without limit, while others may not, mutual limitation is necessitated. The non-ethical form of the right to pursue ends, passes into the ethical form when there is recognized the difference between acts which can be performed without transgressing the limits, and others which can not be so performed.

This, which is the *a priori* conclusion, is the conclusion yielded *a posteriori*, when we study the doings of the uncivilized. In its vaguest form, mutual limitation of spheres of action, and the ideas and sentiments associated with it, are seen in the relations of groups to one another. Habitually there come to be established certain bounds to the territories within which each tribe obtains its livelihood; and these bounds when not respected are defended. Among the Wood-Veddahs, who have no political organization, the small clans have their respective portions of forest; and "these conventional allotments are always honorably recognized."* Of the ungoverned tribes of Tasmania, we are told that "their hunting-grounds were all determined, and trespassers were liable to attack."† And, manifestly, the quarrels caused among tribes by intrusions on one another's territories, tend in the long run to fix bounds and to give a certain sanction to them. As with each inhabited area, so with each inhabiting group. A death in one, rightly or wrongly ascribed to somebody in another, prompts "the sacred duty of blood-revenge"; and though retaliations are thus made chronic, some restraint is put on new aggressions. Like causes and effects were seen in those early stages of civilized societies, during which families or clans, rather than individuals, were the political units; and during which each family or clan had to maintain itself and its possessions against others such. This mutual restraint, which in the nature of things arises between small communities, similarly arises between individuals in each community; and the ideas and usages appropriate to the one are more or less appropriate to the other. Though within each group there is ever

* Tennant, ii, 440. † Bonwick, J., "Daily Life and Origin of the Tasmanians," 83.

a tendency for the stronger to aggress on the weaker; yet, generally, consciousness of the evils resulting from aggressive conduct serves to restrain. Everywhere among primitive peoples, trespasses are followed by counter-trespasses. Says Turner, of the Tannese, "Adultery and some other crimes are kept in check by the fear of club-law." * Fitz-roy tells us that the Patagonian, "if he does not injure or offend his neighbor, is not interfered with by others": † personal vengeance being the penalty for injury. We read of the Uaupés that "they have very little law of any kind; but what they have is of strict retaliation—an eye for an eye and a tooth for a tooth." ‡ And that the *lex talionis* tends to establish a distinction between what each member of the community may safely do and what he may not safely do, and consequently to give a sanction to actions within a certain range but not beyond that range, is obvious. Though, says Schoolcraft of the Chippewayans, they "have no regular government, as every man is lord in his own family, they are influenced more or less by certain principles which conduce to their general benefit": # one of the principles named being recognition of private property.

How mutual limitation of activities originates the ideas and sentiments implied by the phrase "natural rights," we are shown most distinctly by the few peaceful tribes which have either nominal governments or none at all. Beyond those facts which illustrate scrupulous regard for one another's claims among the Todas, Santals, Lepchas, Bodo, Chakmas, Jakuns, Arafuras, etc., we have the fact that the utterly-uncivilized Wood-Veddahs, without any social organization at all, "think it perfectly inconceivable that any person should ever take that which does not belong to him, or strike his fellow, or say anything that is untrue." ‖ Thus it becomes clear, alike theoretically and historically, that while the positive element in the right to carry on life-sustaining activities originates from the laws of life, that negative element which gives ethical character to it, originates from the conditions produced by social aggregation.

So alien to the truth, indeed, is the alleged creation of rights by government, that, contrariwise, rights having been established more or less clearly before government arises, become obscured as government develops, along with that militant activity which, both by the taking of slaves and the establishment of ranks, produces *status;* and the recognition of rights begins again to get definiteness only as fast as militancy ceases to be chronic and governmental power declines.

When we turn from the life of the individual to the life of the society, the same lesson is taught us.

* "Polynesia," p. 86. † "Voyages of the Adventure and Beagle," ii, 167.

‡ Wallace, A. R., "Travels on Amazon and Rio Negro," p. 499.

\# Schoolcraft, "Expedition to the Sources of the Mississippi," v, 177.

‖ B. F., Hartshorne, "Fortnightly Review," March, 1876. See also H. C. Sirr, "Ceylon and the Ceylonese," ii, 219.

Though mere love of companionship prompts primitive men to live in groups, yet the chief prompter is experience of the advantages to be derived from co-operation. On what condition only can co-operation arise? Evidently on condition that those who join their efforts severally gain by doing so. If, as in the simplest cases, they unite to achieve something which each by himself can not achieve, or can achieve less readily, it must be on the tacit understanding, either that they shall share the benefit (as when game is caught by a party of them) or that if one reaps all the benefit now (as in building a hut or clearing a plot) the others shall severally reap equivalent benefits in their turns. When instead of efforts joined in doing the same thing different things are effected by them—when division of labor arises, with accompanying barter of products, the arrangement implies that each in return for something which he has in superfluous quantity, gets an approximate equivalent of something which he wants. If he hands over the one and does not get the other, future proposals to exchange will meet with no response. There will be a reversion to that rudest condition in which each makes everything for himself. Hence the possibility of co-operation depends on fulfillment of contract, tacit or overt.

Now this which we see must hold of the very first step toward that industrial organization by which the life of a society is maintained, must hold more or less fully throughout its development. Though the militant type of organization, with its system of *status* produced by chronic war, greatly obscures these relations of contract, yet they remain partially in force. They still hold between freemen, and between the heads of those small groups, which form the units of early societies; and in a measure they still hold within these small groups themselves; since survival of them as groups, implies such recognition of the claims of their members, even when slaves, that in return for their labors they get sufficiencies of food, clothing, and protection. And when, with diminution of warfare and growth of trade, voluntary co-operation more and more replaces compulsory co-operation, and the carrying on of social life by exchange under agreement, partially suspended for a time, gradually re-establishes itself; its re-establishment brings the possibility of that vast elaborate industrial organization by which a great nation is sustained.

For in proportion as contracts are unhindered and the performance of them certain, the growth is great and the social life active. It is not now by one or other of two individuals who contract, that the evil effects of breach of contract are experienced. In an advanced society, they are experienced by entire classes of producers and distributors which have arisen through division of labor; and eventually they are experienced by everybody. Ask on what condition it is that Birmingham devotes itself to manufacturing hardware, or part of Staffordshire to making pottery, or Lancashire to weaving cotton? Ask how the rural people who here grow wheat and there pasture cattle, find it possible to occupy themselves in their special businesses? These groups can severally do it only if each gets from the others in exchange for its own surplus product, due shares of their surplus products. No longer directly effected by barter, this obtainment of their respective shares of one another's products is indirectly effected by money; and if we ask how each division of producers gets its due amount of the required money, the answer is—by fulfillment of contract. If Leeds makes woolens and does not, by fulfillment of contract, receive the means of obtaining from agricultural districts the needful quantity of food, it must starve, and stop producing woolens. If South Wales smelts iron and there comes no equivalent agreed upon, enabling it to get fabrics for clothing, its industry must cease. And so throughout, in general and in detail. That mutual dependence of parts which we see in social organization, as in individual organization, is possible only on condition that while each part does the particular kind of work it has become adjusted to, it receives its proportion of those materials required for repair and growth, which all the other parts have joined to produce: such proportion being settled by bargaining. Moreover, it is by fulfillment of contract that there is effected a balancing of all the various products of the various needs—the large manufacture of knives and the small manufacture of lancets; the great growth of wheat and the small growth of mustard-seed. The check on undue production of each commodity results from finding that after a certain quantity, no one will agree to take any further quantity on terms that yield an adequate money equivalent. And so there is prevented a useless expenditure of labor in producing that which society does not want.

Lastly, we have to note the still more significant fact that the condition under which only, any specialized group of workers can grow when the community needs more of its particular kind of work, is that contracts shall be free and fulfillment of them enforced. If when, from lack of material, Lancashire failed to supply the usual amount of cotton-goods, there had been such interference with contracts as prevented Yorkshire from asking a greater price for its woolens, which it was enabled to do by the greater demand for them, there would have been no temptation to put more capital into the woolen manufacture, no increase in the amount of machinery and number of artisans employed, and no increase of woolens: the consequence being that the whole community would have suffered from not having deficient cottons replaced by extra woolens. What serious injury may result to a nation if its members are hindered from contracting with one another, was well shown in the contrast between England and France in respect of railways. Here, though considerable obstacles were at first raised by the legislating classes, the obstacles were not such as prevented capitalists from investing, engineers from furnishing directive skill, or contractors from undertaking works; and the high interest originally obtained on investments, the great profits made by contractors, and the large payments received by engineers, led to that drafting of money, energy, and ability, into railway-making, which rapidly developed our railway-system, to the enormous increase of our national prosperity. But when M. Thiers, then Minister of Public Works, came over to inspect, and having been taken about by Mr. Vignoles, said to him when leaving:—"I do not think railways are suited to France,"* there resulted from the consequent policy of hindering free contract, a delay of "eight or ten years" in that material progress which France experienced when railways were made.

What do all these facts mean? They mean that for the healthful activity and due proportioning of those various industries, professions, etc. which maintain and aid the life of a society, there must, in the first place, be no restrictions on men's liberties to make agreements with one another, and there must, in the second place, be an enforcement of the agreements which they do make. As we have seen, the checks naturally arising to each man's actions when men become associated, are those only which result from mutual limitation; and there consequently can be no resulting check to the contracts they voluntarily make: interference with these is interference with those rights to free action which remain to each when the rights of others are fully recognized. And then, as we have seen, enforcement of their rights implies enforcement of contracts made; since breach of contract is indirect aggression. If, when a customer on one side of the counter asks a shopkeeper on the other for a shilling's worth of his goods, and, while the shopkeeper's back is turned, walks off with the goods without leaving the shilling he tacitly contracted to give, the case differs in no essential way from robbery. Similarly, if analyzed, every breach of contract proves to be a case in which the individual injured is deprived of something he possessed, without receiving the equivalent something bargained for; and is in the condition of having expended his labor without getting benefit—has had an essential condition to the maintenance of life infringed.

Thus, then, it results that to recognize and enforce the rights of individuals, is at the same time to recognize and enforce the conditions to a normal social life. There is one vital requirement for both.

Before turning to those corollaries which have practical applications, let us observe how the special conclusions drawn converge to the one general conclusion originally foreshadowed—glancing at them in reversed order.

We have just found that the prerequisite to individual life is in a double sense the prerequisite to social life. The life of a society in

* "Address of C. B. Vignoles, Esq., F. R. S., on his Election as President of the Institution of Civil Engineers, Session 1869–'70," p. 53.

whichever of two senses conceived, depends on maintenance of individual rights. If it is nothing more than the sum of the lives of citizens, this implication is obvious. If it consists of those many unlike activities which citizens carry on in mutual dependence, still this aggregate impersonal life rises or falls according as the rights of individuals are enforced or denied.

Study of men's politico-ethical ideas and sentiment, leads to allied conclusions. Primitive peoples of various types show us that before governments exist, immemorial customs recognize private claims and justify maintenance of them. Codes of law independently evolved by different nations, agree in forbidding certain trespasses on the persons, properties, and liberties of citizens; and their correspondences imply, not an artificial source for individual rights, but a natural source. Along with social development, the formulating in law of the rights pre-established by custom, becomes more definite and elaborate. At the same time, Government undertakes to an increasing extent the business of enforcing them. While it has been becoming a better protector, Government has been becoming less aggressive—has more and more diminished its intrusions on men's spheres of private action. And, lastly, as in past times laws were avowedly modified to fit better with current ideas of equity, so now, law-reformers are guided by ideas of equity which are not derived from law but to which law has to conform.

Here, then, we have a politico-ethical theory justified alike by analysis and by history. What have we against it? A fashionable counter-theory which proves to be unjustifiable. On the one hand, while we find that individual life and social life both imply maintenance of the natural relation between efforts and benefits; we also find that this natural relation, recognized before Government existed, has been all along asserting and reasserting itself, and obtaining better recognition in codes of law and systems of ethics. On the other hand, those who, denying natural rights, commit themselves to the assertion that rights are artificially created by law, are not only flatly contradicted by facts, but their assertion is self-destructive: the endeavor to substantiate it, when challenged, involves them in manifold absurdities.

Nor is this all. The reinstitution of a vague, popular conception in a definite form on a scientific basis, leads us to a rational view of the relation between the wills of majorities and minorities. It turns out that those co-operations in which all can voluntarily unite, and in the carrying on of which the will of the majority is rightly supreme, are co-operations for maintaining the conditions requisite to individual and social life. Defense of the society as a whole against external invaders, has for its remote end to preserve each citizen in possession of such means as he has for satisfying his desires, and in possession of such liberty as he has for getting further means. And defense of each citizen against internal invaders, from murderers down to those who inflict nuisances on their neighbors, has obviously the like end—an end desired by every one save the criminal and disorderly. Hence it follows that for maintenance of this vital principle, alike of individual life and social life, subordination of minority by majority is legitimate; as implying only such a trenching on the freedom and property of each, as is requisite for the better protecting of his freedom and property. At the same time it follows that such subordination is not legitimate beyond this; since, implying as it does a greater aggression upon the individual than is requisite for protecting him, it involves a breach of the vital principle which is to be maintained.

Thus we come round again to the proposition that the assumed divine right of parliaments, and the implied divine right of majorities, are superstitions. While men have abandoned the old theory respecting the source of State-authority, they have retained a belief in that unlimited extent of State-authority which rightly accompanied the old theory, but does not rightly accompany the new one. Unrestricted power over subjects, rationally ascribed to the ruling man when he was held to be a deputy-god, is now ascribed to the ruling body, the deputy-godhood of which nobody asserts.

Opponents will, possibly, contend that discussions about the origin and limits of governmental authority are mere pedantries. "Government," they may perhaps say, "is bound to use all the means it has, or can get, for furthering the general happiness. Its aim must be utility; and it is warranted in employing whatever measures are needful for achieving useful ends. The welfare of the people is the supreme law; and legislators are not to be deterred from obeying that law by questions concerning the source and range of their power." Is there really an escape here? or may the opening be effectually closed?

The essential question raised is the truth of the utilitarian theory as commonly held; and the answer here to be given is that, as commonly held, it is not true. Alike by the statements of utilitarian moralists, and by the acts of politicians knowingly or unknowingly following their lead, it is implied that utility is to be directly determined by simple inspection of the immediate facts and estimation of probable results. Whereas, utilitarianism as rightly understood, implies guidance by the general conclusions which analysis of experience yields. "Good and bad results can not be accidental, but must be necessary consequences of the constitution of things"; and it is "the business of Moral Science to deduce, from the laws of life and the conditions of existence, what kinds of action necessarily tend to produce happiness, and what kinds to produce unhappiness." * Current utilitarian speculation, like current practical politics, shows inadequate consciousness of natural causation. The habitual thought is that, in the absence of

* "Data of Ethics," § 21, and §§ 56–62.

some obvious impediment, things can be done this way or that way; and no question is put whether there is either agreement or conflict with the normal working of things.

The foregoing discussions have, I think, shown that the dictates of utility, and, consequently, the proper actions of governments, are not to be settled by inspection of facts on the surface, and acceptance of their *prima facie* meanings; but are to be settled by reference to, and deduction from, fundamental facts. The fundamental facts to which all rational judgments of utility must go back, are the facts that life consists in, and is maintained by, certain activities; and that among men in a society, these activities, necessarily becoming mutually limited, are to be carried on by each within the limits thence arising, and not carried on beyond those limits: the maintenance of the limits becoming, by consequence, the function of the agency which regulates society. If each, having freedom to use his powers up to the bounds fixed by the like freedom of others, obtains from his fellow-men as much for his services as they find them worth in comparison with the services of others—if contracts uniformly fulfilled bring to each the share thus determined, and he is left secure in person and possessions to satisfy his wants with the proceeds; then there is maintained the vital principle alike of individual life and of social life. Further, there is maintained the vital principle of social progress; inasmuch as under such conditions, the individuals of more worth will prosper and multiply more than those of less worth. So that utility, not as empirically estimated, but as rationally determined, enjoins this maintenance of individual rights; and, by implication, negatives any course which traverses them.

Here, then, we reach the ultimate interdict against meddling legislation. Reduced to its lowest terms, every proposal to interfere with citizens' activities further than by enforcing their mutual limitations, is a proposal to improve life by breaking through the fundamental conditions to life. When some are prevented from buying beer that others may be prevented from getting drunk, those who make the law assume that more good than evil will result from interference with the normal relation between conduct and consequences, alike in the few ill-regulated and the many well-regulated. A government which takes fractions of the incomes of multitudinous citizens for the purpose of sending to the colonies some who have not prospered here, or for building better industrial dwellings, or for making public libraries and public museums, etc., etc., takes for granted that, not only proximately but ultimately, increased general happiness will result from transgressing the essential requirement to general happiness—the requirement that each shall enjoy all those means to happiness which his actions, carried on without aggression on others, have brought him. In other cases we do not thus let the immediate blind us to the remote. We do not when asserting the sacredness of property against private aggressors, ask whether the benefit to the hungry man who takes bread from a baker's shop, is or is not greater than the injury inflicted on the baker: we consider not the special effects but the general effects which arise if property is insecure. But when the State exacts further amounts from individuals, or further restrains their liberties, we consider only the direct and proximate effects, and ignore the indirect and distant effects which arise when these invasions of individual rights are continually multiplied. We do not see that by accumulated small infractions of them, the vital conditions to life, individual and social, come to be so little fulfilled that the life decays.

Yet the decay thus caused becomes manifest where the policy is pushed to an extreme. Any one who studies, in the writings of MM. Taine and De Tocqueville, the state of things which preceded the French Revolution, will see that that tremendous catastrophe came about from so excessive a regulation of men's actions in all their details, and such an enormous drafting away of the products of their actions to maintain the regulating organization, that life was fast becoming impracticable. The empirical utilitarianism of that day, like the empirical utilitarianism of our day, differed from the rational utilitarianism in this, that it contemplated only the effects of particular interferences on the actions of particular classes of men, and ignored the effects produced by a multiplicity of such interferences upon the lives of men at large. And if we ask what then made, and what now makes, this error possible, we find it to be the political superstition that governmental power is subject to no restraints.

When that "divinity" which "doth hedge a king," and which in our day has left a glamour around the body inheriting his power, has quite faded away—when it begins to be seen clearly that, in a popularly-governed nation, the government is simply a committee of management; it will also be seen that this committee of management has no intrinsic authority. The inevitable conclusion will be that its authority is given by those appointing it; and has just such bounds as they choose to impose. Along with this will go the further conclusion that the laws it passes are not in themselves sacred; but that whatever sacredness they have, is entirely due to the ethical sanction—an ethical sanction which, as we find, is derivable from the laws of human life as carried on under social conditions. And there will come the corollary that when they have not this ethical sanction they have no sacredness, and may rightly be challenged.

The function of Liberalism in the past was that of putting a limit to the powers of kings. The function of true Liberalism in the future will be that of putting a limit to the powers of Parliaments.

COLORADO FOR INVALIDS.

By SAMUEL A. FISK, M.D.

THE romantic features of life in the Rocky Mountains have been so gracefully portrayed by such facile pens as those of Bayard Taylor, "H. H.," Miss Bird, and some of our magazine-writers, that the reading public have come to regard this country as adapted either to the tourist, bent on seeking something unusual, looking for novel and startling experiences, or else as an immense treasury of gold and silver, an El Dorado for the miner. But there is a larger class, that portion of our population throughout the East and South suffering from some pulmonary trouble, which should be much more interested in Colorado than either the pleasure-seeker or the money-getter. For such there is a wealth of life stored up in the dry, sunny climate of this State, more precious than the hidden treasures which the mountains contain.

It is the intention of the writer to supplement some past efforts in calling the attention of the public to this salubrious climate, by giving a few details in regard to methods of living, society, resorts, expenses, occupations for the invalid, etc.; and he is led to this by the lack of information that he has found, from a personal experience, exists among Eastern people in regard to these very points, and by the erroneous impressions which he finds most new-comers have as to what they are to expect.

Before entering into these details, it may be well to call attention, very briefly, to the climatic conditions existing in Colorado, which are favorable to the arrest and cure of a large percentage of pulmonary troubles. A careful analysis of Signal-Service statistics for a range of years has shown that the climate of Colorado affords an air only $\frac{4}{10}$ saturated with moisture, while the air of Jacksonville, Florida, is $\frac{7}{10}$, and that of Los Angeles, California, is $\frac{66}{100}$ of saturation; that the average rain- and snow-fall, per annum, is only a trifle over fourteen inches, while at Jacksonville it is forty-nine inches, at Los Angeles nineteen inches, and at New York forty-two inches; that the elevation, ranging from five thousand to seven thousand feet, is such as secures the most healthful action for diseased lungs; that the direction and daily motion of the winds are favorable and salubrious; that the mean temperature would place this climate under the head of a "cool climate"; and, lastly, and of the greatest importance, is the fact that it affords an average of three hundred and twenty sunny days per annum, or, to quote the article referred to:* "It is seen that in Denver there is only about one eighth of the entire year when an invalid would be kept in the house on account of the weather; in Jacksonville and Au-

* "Science," vol. ii, No. 35, p. 460.

gusta (Georgia) he would be confined to the house, for the same reason, one quarter of the year; in St. Paul he would be kept in-doors between a third and a quarter of the time; while in Boston he would have to be housed a good third of the time."

Many invalids who recognize the force of these data would, nevertheless, hesitate to come to Colorado because of their impression that the people are rough and only semi-civilized, and that the lack of accommodations is so great as to make life, especially for a lady, unendurable. Persons, gaining their information from newspapers, have a vague idea that the State is infested by the cow-boy element, that everybody carries fire-arms, that society is lawless or at the best crude, and that social life is regulated by the *nouveaux riches*. Such persons would be astonished at the facts in the case. In Denver they will find regular and well-laid streets, numerous and magnificent public buildings, imposing rows of business blocks, numerous and flourishing banks, stately churches, and, above all, comfortable and wealthy homes. A personal investigation will convince any one that Denver is the finest, cleanest, most healthful, and by far the most imposing, of any of the so-called new cities in the United States. It is a false impression that leads any one to think that affairs are crude in Colorado. Throughout the State, even in the smallest towns, are to be found people of culture and refinement. It is a noteworthy fact that the average of education is higher here than in almost any other part of the Union, and there is not a town in the State that is wanting a circle of people who have both read and traveled. It is also a mistaken impression that lawlessness prevails. In the mountains one can go anywhere unarmed, while in the centers life and property are as secure as in the East.

It is an equally mistaken idea that would cause one to hesitate about coming to Colorado for fear of the privations he would have to endure. Throughout the State the comforts of living, in any given place, are as great as they would be in a place of equal size East. Most of the towns are supplied with water- and gas-works. The markets have fruits and vegetables in their seasons, and fish and oysters from the coast. Such articles as groceries, clothing, furniture, are to be had as readily here as elsewhere. Hotel accommodations are as good as, if not better than, are to be found in most places of equal size East.

It should be remembered, however, that the expenses of living may be higher in Colorado, which is a new country, than in the older and more settled portions of the Union. This is to be accounted for partially by the fact that the home production is inadequate to the consumption, by the great distance that intervenes between this State and the centers of supply, and by the fact that it is impossible to grow certain things in this soil. As the question of expense is often of prime importance to invalids who would like to come to Colorado, it may not be out of place to give a few brief details. A first-class railroad ticket from Chicago to Denver costs thirty-seven dollars ; a berth in the sleeper is eight dollars ; meals are seventy-five cents apiece. Hotel accommodations in Denver range from two to four dollars a day. Comfortably furnished rooms can be found at from twelve to twenty dollars a month, and good board costs from five to ten dollars a week. These are not bottom figures, but are means. House-rents and servants' wages are somewhat higher than in the East.

The invalid having determined to come to Colorado, the question then arises as to the best place for him to go. This is a point of considerable importance, and one in regard to which very erroneous advice is frequently given by physicians unacquainted with the State. For instance, it is not an uncommon thing for Eastern physicians to advise their patients to go into one of the parks in mid-winter, when, in point of fact, the snow would be lying so deeply on the ground in these places that it would be impossible to get into them, and certainly very injudicious for an invalid to attempt it. As a broad rule it can be stated that the best points in which to winter are the towns situated at the junction of the plains and foot-hills. In the summer the invalid will do well to go into the mountains, to such places as Estes Park, Manitou Park, Poncha Springs, Wagon-wheel Gap, Georgetown, or Idaho Springs.

The most available towns for the invalid who has to earn his support are Denver and Pueblo, but there is a moderately wide field from which to choose when health and comfort, and not money, are the main considerations. Colorado Springs combines so many favorable conditions of climate, good accommodations, pleasant society, and natural objects of interest, as to render it, in addition to its sanitary condition, an almost ideal resort for phthisical invalids. Six miles to the west of Colorado Springs, nestling among the foot-hills at the base of Pike's Peak, is Manitou, the so-called "Saratoga of the West." Its winter climate is mild, but it is chiefly a summer resort, as its large hotel accommodations, its iron and soda springs, its baths and drives, make it exceedingly popular. These springs furnish a large flow of agreeable drinking-water of real medicinal value. The soda-spring water resembles the Apollinaris, while the "Iron Ute" carries, in addition to the carbonates of soda, lime, and magnesia, a percentage of iron sufficient to give a marked reaction to the prussiate-of-potassium test. At Poncha Springs there is an abundant flow of a hot chalybeate water, containing in addition salts of sulphur, soda, lime, and magnesia in solution. The mean temperature of these springs is 150° Fahr., and they are considered to be very valuable in the cure of rheumatism and kindred troubles. The natural location of Poncha is one of the finest in the State, and it must in time become one of the well-known resorts. At present the hotel accommodations are meager and insufficient. Idaho Springs is a popular resort, adapted to both winter and summer. The springs furnish agreeable bathing, the climate is mild and stimulating; it is so sheltered from the winds as to be warm, even in winter, and socially it is attractive. The hot springs at Las Vegas, New Mexico, combine the advantages of a good winter climate, excellent hotel accommodations, and baths of natural hot water. The temperature of these springs varies from 71° to 136° Fahr., and they contain salts of soda and lime. We give tables showing the constituents of these several waters:

IN 100,000 PARTS OF SPRING-WATER ARE CONTAINED—	MANITOU.	MANITOU.	LAS VEGAS.	IDAHO SPRINGS.	WAGON-WHEEL GAP.
	Iron Ute, 44° F. (Wheeler expedition).	Soda, 44° F. (Wheeler expedition).	No. 13, 186° F.	110° F.	150° F. (Wheeler expedition).
Carbonate of soda	59·34	88·80	1·50	52·81	69·42
Carbonate of lithia	trace	trace	....	...	trace
Carbonate of lime	59·04	108·50	3·01	16·32	13·08
Carbonate of magnesia	14·56	....	....	4·94	10·91
Carbonate of iron	5·78	....	....	7 07	....
Sulphate of potassium	7·01	5·12	....	....	trace
Sulphate of soda	30·86	37·08	17·72	50·34	23·73
Chloride of soda	31·59	42·12	28·03	7·13	29·35
Silica	2·69	trace	6·16	6·99	5·73
Solid residue	....	....	57·00	....	trace
Sulphate of magnesia	....	....	....	32·09	....
Total	210·87	281·62	113·42	177·69	152·12

Denver itself makes a good winter resort, as it combines the comforts and attractions of a city with a dry, warm, and sunny climate. But no directions can be given as regards the place that is best suited to any individual case; that should be determined by some competent physician who would take into consideration the demands of the case and the season of the year. In the summer it is well for the invalid to go into the mountains, either camping out or going to some of the resorts; in the winter, let him do as the Indians did, come down to the edge of the plains.

The inclination to exercise to excess and to overdo is a tendency which the phthisical invalid should guard against. The increased activity of the heart, bearing in its train an increase of metamorphosis and an exalted vitality, frequently leads the invalid to overrate his strength and to exercise too violently. In this way irreparable injury is not infrequently done. The exhilaration produced by the tonic air, coupled with the restlessness incident to change of scene, often induce patients, who should be resting and becoming acclimated, to take long and exhausting walks, or to ride distances that would tax the energies of a well man. It is difficult for most phthisical invalids to understand that they are not as strong as they once were, and to teach them that exercise does not mean exhausting effort. There is a wrong impression, common to this class, which leads them to think that in order to regain health they must be in constant motion, and that the more they can be doing the sooner they will get well. They forget that their disease is in itself a tremendous drain upon their vitality, and that any additional strain is to be avoided. When the heart has become accustomed to the additional work put upon it, by reason of the increase in elevation, and the system has adapted itself to the new conditions by which it is surrounded, it is well to undertake exercise of a moderate character, and the best is riding horseback. Fortunately, the price of ponies (from sixty to one hundred dollars) is so reasonable and the sport so popular as to make this form of exercise both possible and attractive to every invalid.

There is another fallacy inherent in the minds of many consumptives, coming to Colorado, which should be mentioned; that is the idea that the climate is the only factor in the cure of phthisis, and that it will be sufficient for them simply to be breathing this dry air in order to secure a complete recovery. It is most absurd to imagine that an invalid can disregard all the laws of hygiene and health, can keep irregular hours, smoke incessantly, disregard all changes of temperature, expose himself in every possible way to cold, in order that he may become "toughened," and then expect that the climate is going to work wonders in curing his trouble. And yet many a one, leading just this type of life, grumbles at the climate, and wonders that he does not recover his health!

This leads us to speak of the matter of clothing. The ranges of temperature in Colorado are often very large, hence a person should be prepared for both warm and cold weather. In winter one should wear flannels and heavy clothes just as in New York; in summer thin garments will be comfortable at midday, but woolens will be needed at night. The air is so dry and rare, and the soil is so exposed and sandy, that both solar and terrestrial radiation are rapid. The sun's rays heat rapidly, and, they being withdrawn, the air is rapidly cooled. There is, however, this positive fact which makes thermometric variations unfair criteria on which to base comparisons as between Colorado and the East. As has been shown, this air is exceedingly dry, and consequently heat and cold, as indicated by the registration of the mercury, are not felt as much as in New York. Mists are seldom seen here, and dew is rarely deposited.

The question of occupation for the invalid is one of prime importance, and has almost as direct a bearing upon his recovery as have climate and proper care. Even if it be true that consumptives are, as a rule, sanguine about themselves, it is equally true that, if a man has nothing to think of but his health, he soon becomes a hypochondriac—a disease as much to be dreaded as any real malady—and every physician, who has had much experience with chronic invalids, knows how important it is that the mind should be "diverted." The writer regards it as a great mistake for the phthisical invalid to be without some definite plans and occupation. As soon as practicable, it is advisable for such a one to take up some pursuit, either of business or of study, which will give such occupation as is consistent with his physical condition. The geology, mineralogy, fauna and flora of this State, so rich in themselves and so different from those in the East, furnish, to one so disposed, ample fields of study and inquiry, the pursuit of which will be a help rather than a hindrance to recovery. The collecting of a cabinet, requiring as it would something of an out-of-door life, or the getting together of an herbarium of all the choice and unusual flowers and plants of this State, would furnish occupation of an instructive and diverting kind. If one undertakes to study even the birds, he will be surprised to find how many species there are, and will be equally astonished to discover among them his old friends the bobolink, wren, oriole, and the indigo-bird, of the Eastern States.

It may be a good thing for the person affected with phthisis to go into ranching, after he has been in the State long enough to know what he is about in doing so; but we enter a protest against the idea, which is somewhat prevalent in the East, that in order to recover his health the invalid should go on to a ranch and herd sheep. The reasons for making this protest are that such advice is frequently given, and, as we are led to judge, by physicians who have but the vaguest ideas of the nature of the course they are prescribing. The invalid, on coming to Colorado, needs to have life made as easy and pleasant for him as possible. As a rule, the sacrifices he has to make, in consequence of his sickness, render him for the time being peculiarly dependent upon sympathy. He should be so situated that he can have the benefit of pleasant society and diverting companionship. Now, ranch-life is necessarily somewhat rough and usually monotonous, and, when it comes to herding sheep, even a vigorous man, new at the business, finds it most irksome and fatiguing. We think it is a great mistake to increase the trials of an invalid by imposing upon him, in addition to a separation from his friends, an almost entire absence of companionship, a life that is rough in the extreme, and a dietary that is innutritious, uninviting, and monotonous. The average ranch-house is a miserable shanty, out on the plains, away from neighbors, where the usual diet is bacon floating in grease; hot flapjacks, made fresh with water and baking-powder; molasses, and coffee without milk.

If it be possible for the invalid to go to some nice ranch, near a village, where he can have good, wholesome diet, pleasant associates, out-of-door occupation, and where his hours will necessarily be regular, then the conditions for recovery are excellent. Such ranches are to be found. But the average ranch, on the plains, is much inferior to the average farm-house in the East, and the surroundings and diet are such as, at first, to try very severely the strongest man.

The matter of diet is one to which, as it seems to the writer, sufficient attention is not usually paid by the invalid. He should be so situated that he can have an abundance of plain, nutritious food, well cooked, and a variety sufficient to invite the palate. It stands to reason that if the waste in the system, produced by the disease, is not only to be made good, but if, in addition, as is desirable, the patient is to put on fat, he must take into his system material sufficient in quality and quantity wherewith to do it. Any place, be it on a ranch or at a boarding-house, where the table is uninviting and nauseous, is a bad one for the invalid, and one that he should leave as soon as possible. It is on this ground that we base a good deal of our objection to ranch-life. As indicated, the food is usually poor in quality, insufficient in quantity, and indigestible. Contrary to what might be supposed, even on a cattle-ranch, milk is seldom to be had, and, if the black coffee is to be drunk *au lait*, it is made so with condensed milk. The life, also, is monotonous and trying, and the distance from medical assistance, if needed, is so great as to be, in hæmorrhagic cases, of serious importance. The writer is convinced that ranch-life, the so-called "ranch-cure for consumptives," especially those just out from the East, is a mistake; and he is certain that its good qualities, in giving occupation and an out-of-door life, are to be had without the bad ones, by going to some one of the many towns on the eastern slopes of the Rocky Mountains.

In conclusion, it may be appropriate to speak very briefly of the classes of pulmonary troubles to which this climate is adapted. It will not be possible to give a complete list, nor to attempt to catalogue the varieties, but merely to mention, in the most general way, the kinds of pulmonary disease that experience has shown to be relieved in Colorado. It may not be inappropriate to begin with a strong negative, and to say that this climate is *not* adapted to persons suffering from the last stages of phthisis. The elevation and rarity of the air throw so much extra work on the already embarrassed heart and lungs that the difficulty is increased and the end is only hastened. Such cases need the comforts of home, and the consolation of friends, more than change of scene or climate; and we protest against the cruelty of sending such invalids to Colorado as a *dernier ressort*, when the probable issue will be that they have been subjected to an exhausting and fatiguing journey only to give up their life, in a short time, in a strange land. The opinion that the altitude is not suited to hæmorrhagic cases is generally discountenanced by the medical profession in this State. Such cases are found to do very well here if they be taken early enough; and experience shows that there is nothing in mere altitude to increase the tendency to relapses. Even those cases where there is a strong hereditary tendency to phthisis are found to do admirably in this climate, provided they come early enough. The so-called catarrhal pneumonias, in the early stages, where resolution is slow, are admirably adapted to this climate. Bronchitic and asthmatic patients find relief and cure here. Where heart-lesions exist, especially if they be complicated with dilatation, elevation is contraindicated. Many cases of nasal and pharyngeal catarrh do admirably here, and deafness, arising from chronic catarrh of the middle ear, is frequently cured. In general, Colorado will be found to be an admirable resort for enfeebled and debilitated persons who need rest, change of scene, and general "toning up."

It has become a by-word that there are two classes of persons who come to Colorado—those who come to get health, and those who come for wealth. We think that the former more often realize their anticipations, and, having found a new interest in life, in consequence of their return to health, they show their appreciation and gratitude by remaining in the air and sunshine that have made "life new around them." How often one hears the expression, "I owe everything to Colorado air," it is impossible to say; but so large a class of our population have sought and found a restoration of health here, that one can not refrain from carrying the good tidings to the thousands upon thousands in the East who are seeking wherewith they may be cured.

THE NEW THEOLOGY.

By Rev. GEORGE G. LYON.

ASSUMING that the Being worthy of the highest adoration in heaven and on earth must be incomprehensible, and that his will and ways must be past finding out, no conceivable symbol can be final, or can be either satisfactory or helpful, except in a period of immaturity; and hence nothing can be more necessary than a new faith, or more reasonable than its confident and constant expectation; and that which is now dawning on the Christian world is doubtless destined to have its day. They who have toiled hard and borne the heat and labor of the preceding day and feel the need of rest, and they who dislike the dawn and love to slumber until noon, will be more annoyed than gratified by the light of this new morning; but they who are up with the rising sun will be delighted with the dispersing darkness and the increasing brightness, and with the new beauties and the fresh fragrance of the clearer light and higher life.

Thus far in its presentation the New Theology is reformatory rather than revolutionary in its teachings and tendencies. It accepts the nomenclature of the Old, but shades or expands its definitions so as to accord with the subtiler experiences and the enlarged observations of the age; and it maintains the dogmatic statements of the Old, but modifies their exposition so as to bring them into harmony with the laws and processes of being. It affirms with the Old that faith is the basis of salvation and of all deliberate activity, but it gives no pre-eminence to any form of faith, and tests the validity and the sufficiency of a faith by the salvation it secures and the activity it inspires. With the Old it accepts all Scripture given by inspiration as divine, and interprets Scripture by Scripture, but it holds in abeyance all biblical utterances which seem unreasonable, and rejects all which are in conflict with the nature of things or the course of Providence, and aims to understand and to corroborate the written word by the works of Nature; and it maintains that no portion of the Scripture can be a revelation of God to man except to the extent that it is understood and conforms to the laws of being.

One of the most distinguishing characteristics of the New Theology is its respect for science, indicated by its effort to put all its statements on a scientific basis and submit them in a scientific method, and to question the value or utility of any doctrine which does not come under some general and harmonious law, or which can not be scientifically presented; and, were this the only claim of the New Theology, it would entitle it to a respectful hearing, as well as put it in striking contrast with the Old. It does not insist that any of the great doctrines derived from the Bible could have been discovered by scientific investigation, but, being disclosed by divine inspiration, as claimed, they are, when philosophically considered, recognized as reasonable and essential, and to be in accord with the constitution of things. It contends that the dogmatic teachings with respect to the trinity of the Godhead, the divinity of Christ, the atonement or human redemption in Christ, the inspiration of the Scriptures, the immortality of the soul, salvation by faith, the operations of the Holy Spirit, human probation, the eternity of divine rewards and punishments, and other biblical doctrines, are no longer to be announced as abstract truths to be received by a stultified credulity and denied at the peril of the soul, but are illumined under the light of philosophy as natural and essential, and can be as rationally believed as any other inexplicable statements of experience or observation.

As a corollary to this respect for science the New Theology has an antipathy to authority, and insists on personal freedom in investigation, and personal responsibility for conviction. It concedes that authority is necessary as a guide in immaturity, and that most of the knowledge acquired by individuals is derived, but holds that no *ipse dixit* is final, and that all communication is to be received tentatively and subject to amendment or rejection; that authority is merely mechanical in its action and in its effect, and that they who submit to it without question are mere machinery propelled like an engine by steam, capable of valuable service for a season, but neither develop nor improve, and are deprived of all the pleasures of progress and of increasing vigor and usefulness. It goes further, and charges that commanding authority dwarfs growth and weakens ability, and is, therefore, largely responsible for the general inability to distinguish between right and wrong, and for the unsettled and weak convictions as to good and evil; and, furthermore, that it is accountable for much of the prevailing unbelief and skepticism, for, without some collateral and corroborative evidence to support naked affirmations, faith becomes weak, and lapses into superstitious credulity, or is abandoned for the more satisfactory—if not more intelligent—negations of infidelity and agnosticism. And it must be admitted that it has always been difficult to hold the average of Christians to an unfaltering faith in the evangelical doctrines of Christianity—the Trinity, the divinity of Christ, the atonement, etc.—that but few have a clear conception of any of them, that many deny one or more of them, that no two understand them alike, and that all have doubts and fears with respect to them; and, therefore, the New Theology most earnestly protests against the arbitrary and inconsiderate church canon which exacts unreserved or even nominal assent to all or to any articles of faith as a requirement of God and a condition of the divine favor and the soul's salvation. It does not question the soundness of the doctrines affirmed, but it recognizes the impossibility of making all men see them alike, or of holding them to a credulous assent to them; and affirms that many who doubt and many who disbelieve them are among the most exemplary of mankind; that the sacred Scriptures comprehensively understood do not exact uniformity of faith in order to salvation; and that were any symbol the basis of hope it could not be of universal application, and would, therefore, not be adapted to humanity, or be consistent with either the divine or human nature. It assumes that saving faith is that recognition of what is right and best which enforces its practice; and the sincerity and strength of faith are determined by the degree of the conformity of the heart and life of the subject to the character and requirements of the ideal. In other words, the aim and effort of a man to be in accord with what he sincerely regards the true and the perfect, whether that be fetichism or Christianity, is the exercise of saving faith, and secures the soul its highest commendation and the divine favor; and, since its real excellence is in sincerity, it may be as perfect and as acceptable in its first timid appliance by the feeble as in its last bold assurance by the strong.

The New Theology is not a positive philosophy which rejects or agnosticizes the unknowable and the incomprehensible. It accepts authority as the starting-point of inquiry, which is skeptical but open to evidence, and takes the reasonable and the probable rather than the positive or the absolute as the only attainable presumption of truth and error. And since problematic conviction constitutes the sum of all human knowledge, and forms the basis of all human activity, it regards as impractical theorists, insensible to the operative agencies of the ages, all who reject the probable for the positive.

Starting out with these leading ideas that no creed can be final so long as there is the infinite to explore or the human intellect is capable of comprehending more; that new symbols are of periodicity and of rational expectation, and therefore that all creeds are tentative and adapted only to a transition period; that authority is insufficient, and requires the corroboration of correlative facts or principles of observation to establish faith; that no formula of faith can be adjusted to all comprehensions or made the condition of salvation, and that the probable is the highest and the sufficient warrant for all human faith and practice—it remains to be seen if the New Theology has a clearer or a fuller apprehension of scriptural teaching, and if it can present its ideas less dogmatically and more scientifically, or as authoritative utterances corroborated by corresponding facts or experiences which are generally accepted.

No adherent of the New Theology, however enthusiastic or confident in his early love, presumes that in this dawn of its day its beams are as bright or broad as they will be at its meridian; and the most zealous of its expounders confess that in its present stage it is largely suggestive, and possibly adapted to arrest the reactionary tendency to reject all scriptural teaching as of divine origin or authority on account of the unreasonableness of some of the current theological interpretations and expositions, and to unite thinking Christians and confirm the weak and the wavering in the faith of the gospel, by such a presentation of scripture truths as will be commended by their judgment, and will show them to be essential to human welfare and analogous to the laws and phenomena of Nature. It is therefore chiefly a contribution of suggestive definitions and methods applied to the popular or evangelical theology. But, in order to a clearer idea of the New Theology and its methods, it is necessary to give a brief statement of its presentation of some of the more prominent evangelical doctrines, and especially of those which within the last few years have been made conspicuous through church councils and the religious and secular press, as the atonement, the work of the Divine Spirit, human probation, etc.

As to the nature and necessity of the atonement, the New Theology is perhaps more perplexed than as to any other evangelical topic, if indeed it is not agnostic, or at least without decided convictions; and its adherents consider themselves as mere inquirers, investigating in an obscure light its profound mysteries, trusting that the dark labyrinth in which they are groping will lead to their fuller disclosure. It does not deny that in some way the mission of our Lord accomplished immeasurable good to mankind, for it recognizes a new and diviner life issuing from Calvary and streaming down through the centuries in ever-increasing volume, purifying the hearts and inspiring the lives of men, and constituting the impulsive force to all that is desirable and divine in human progress; but it can not reconcile with a worthy conception of either the divine or human nature the punishment or the suffering of the innocent for the guilty in order to placate the divine anger and render the Deity propitious, or to satisfy the claims of justice so that the Judge can be clement to transgressors of law and permit them, untrammeled by guilt for the past, to reform, or give them another chance to do better. Neither the divine holiness nor justice was ever antagonized to the sinner, and therefore never needed to be conciliated, and certainly neither could ever be reconciled with sin; so that an atonement either to dispose God favorably toward sinners or to tolerate sin, or to make any allowance for sin or to pardon sin, is inconsistent with the divine nature. And nothing can be more absurd than the teaching that God was at enmity with the sinner, unless it be the affirmation of those who believe it, that the atonement is "a provision of divine grace or love"; for, plainly stated, it is this: An atonement or means of reconciliation was necessary because God hated sinners, but was really instituted because "God so loved the world" of sinners. Men feel that God is angry with them and hostile to them, but certainly the atonement of Christ, whatever it be, is counteracting this erroneous sentiment by its disclosure of the infinite and unwavering paternal love of God for man in the life and death of his Son; and any provision of mercy which the divine wisdom and goodness has made for sinners is necessarily predicated on this infinite love of the common Father of the race. And so the New Theology objects to all moral views of the atonement which make provisions for waiving any legal process or infliction of penalty, and holds that no new provision of grace or special scheme of redemption for the recovery of man from the power and dominion of sin was necessary; that all the elements for the restoration from sin to righteousness are included in the provisions of Nature, and are sufficient when quickened and invigorated by the Divine Spirit to reinstate men in holiness and in the favor of God. So that the regeneration of the human soul is as practicable without the mission or work of Christ as an additional agency as with it, for it consists essentially in the deliberate determination henceforth and forever to be at one with God; and from this determinative initiative the optimistic element of the mind brings the peace, courage, and hope of faith. There is nothing now to afflict or discourage except the past, and that is forsaken and abhorred; and since in eternal progress, and effort the soul is in accord with the laws of its being and the Divine Will, it gradually comes to forget, as God does, its backslidings, and to think only of that which is pleasing to God and which will be the source of perpetual delight.

It would not be consistent with the general run of creation had remedial provisions been left out of the moral nature of man while they are incorporated in animal, in vegetal, and in social being; nor would it be consistent with the infinite forethought or consideration or compassion of our Father in heaven to introduce a new agency essential to human welfare which was not of immediate and universal application to the race. It is true, the advent of Christ was of intermediation in time, but in essence of being it was contemporaneous with accountability, and was revealed in prophetic language at the first overture of moral delinquency as the seed of the woman "that should bruise the serpent's head"; and has ever, according to all human experience, been recognized in the ideal of good which reproaches every varying thought and deed, and which constitutes the inspiration and the encouragement to all improvement. The advent and life of our Lord did not therefore impart a new moral element to the world, nor is Christianity a new provision of grace in the plan of human redemption; and the time element in their introduction is a mere question of policy, since they are not of vital importance. That is, it was for divine wisdom to determine when it would be most advantageous to the race to send the quickening example and teaching of Christ into the world, but their advent has in no way modified the relation of God to man, or of man to God, nor made the provisions of human redemption more ample or available. They are incidents in the process of moral progress, and could wisely be introduced only at the proper stage of development, so that the delay in their intercalation can not be reproachful.

The aim of the atonement is to exemplify a condition and life corresponding to, but surpassing, the highest ideals of men, which may be approximately attained by every individual of the race in every stage of accountability; and the effort to realize this condition and life is the acceptance of its provisions and its accounted righteousness or the transfer of Christ's righteousness to the believer; for the faith that impels to be like Christ is transforming in its effect, and by its continuous exercise believers become Christ-like in character and conduct. And this has ever been the result among heathen and Christians of efforts to attain ideal excellence; for the human mind is so constituted that its desirable ideal is always an approximation to the perfection of Christ; and hence the declaration of Peter, "I perceive that God is no respecter of persons, but in every nation he that feareth him and worketh righteousness is acceptable to him"; and hence, also, the Christ-like worthies among Hebrew saints and pagan philosophers, Mohammedan dervishes, Indian fakirs, and fetich-worshipers. Moral processes, corresponding to those accorded to the atonement of Christ, have been going on in all ages and among all races, regenerating the hearts and improving the conduct of all believers—i. e., of all who aimed to realize their ideal excellence; and this regenerating process was probably signified in the occult religious mysteries of the more cultured nations of antiquity. The atonement, therefore, is not a provision for sin or for the sinner, but for man; and, had sin never entered the world, the mission of Christ would have been as necessary to the exaltation and salvation of mankind as it is under the reign and power of sin. It is a practical revelation of an ideal which was essential to the highest good of man, and which could be eternally approximated, but which never could be conceived by man without its disclosure in the life and death of our Lord.

In regard to the supernatural, the New Theology doubts or denies it in the economies of Nature and of grace. It believes in the inspiration of all scriptural and other truth, in the authenticated phenomena called miracles, in the regeneration of corrupted human nature by the power of the Holy Spirit, and in the active and efficient superintendence of divine providence; but it maintains that the divine immanence in the world is sufficient to account for the minutest and the mightiest phenomena which have occurred, or which can take place, and that to assume special divine interferences or the interposition of new agencies in the communication of the Divine Will, in the government of the material or moral world, in the recovery of man from wickedness to righteousness, presumes the "sober second thought" on the part of God that his original executions were defective, and needed amendment or reformation; that he is partial, and favors with advantages one age or one class more than another, and that he is changeable and unreliable. All natural wants, physical and spiritual, are indicative of the divine disposition to help, and are assurances of suitable supplies—material for the body and immaterial for the mind—which, according to all human experience, never ignore nor supersede a natural law or function; and it is doubtful if any supernatural helps could be recognized or appreciated; so that it is not improbable that all that is called supernatural is of misconception, superstition, or credulity. And, if there be no necessity for it, or if that which is so called can be accounted for or accomplished by natural means, its exercise would be a useless display of energy, while, if necessary, it shows that the provisions of Nature are inadequate to its necessities and thereby reproach their author; and if it intervenes to assist, or retard, or counteract, it must be a supersedence of the supernatural by the supernatural—a kingdom divided against itself and self-destructive; for is not Nature, in its being and in its processes, a divine arrangement and incapable of any modification or rearrangement except by a greater than Nature? And to the affirmation that all the divine creations and phenomena are necessarily supernatural, it may be asked: How can there be a supernatural without a natural to exceed? and if supernatural, how can they be superseded unless by a greater than the supernatural? and would it not be useless to introduce the supernatural unless it could exceed a process of Nature or equal an act of creation?

But who knows what Nature is capable of? or if it has ever been superseded? or that any of the operations called supernatural are more than natural? As mankind advances in intelligence, the supernatural retires, like barbarism before civilization; and yet, the prevalent belief of Christians is, that there is a supernatural, spiritual agency in the world which enlightens the mind and transforms the heart of man, and which assures of the divine favor and begets the hope of eternal life; and a less prevalent conviction that this divine element has in times past performed miracles, and may even now be controlled to heal the sick, and cure the lame, and do superhuman deeds.

It is not questioned that there is an enlightening, encouraging, and comforting spiritual influence in the world; but why assume that it is supernatural? or that it is a new and distinct agent which is superior to and supersedes Nature? No one has yet fathomed the mysteries or power of a single element of nature, and therefore can not reasonably assume that Nature is insufficient to account for all the phenomena attributed to the supernatural, nor can any one show that the supernatural has ever done or can do more than is done by Nature in its ordinary processes. And if, as claimed, the natural occurrences are divine operations, then, certainly, no supernatural agency could be more subtile, or more powerful, or more beneficial, than a common process of Nature. Even the advent of Christ can not be regarded as a new or superseding force in human life if he be "God manifest in the flesh," for God has ever made himself known by his works and providence, "even his everlasting power and divinity." The mere form of his appearance would not be a superior component, and if he were a creation he could not be a supernatural power.

The profound conviction of the Christian mind is, that the God who created, upholds the universe, and watches over and guides the movement of every atom day and night, and guards the thoughts of every heart and gives them the impulse of their transforming energy. This is the divine in nature, and there could be no course of nature without it; but it is neither a new, nor a distinct, nor a superseding element in nature. It is God as the ever-present and efficient force in matter and mind, who "rides in the whirlwind and guides in the storm," who lives, and moves, and has his being in the human heart, and who helps in every infirmity. He is the unseen, intangible subsistence in and of self, and yet not self, which purifies the heart and ennobles the life, and which improves society, and "makes for righteousness" from age to age, and to the ends of the earth.

He is the Holy Spirit, sent by our Lord, who vitalizes every letter and word of the Divine utterances, and abides in them so that they are living words, and scintillate with the radiance of their divine significance as the light from the urim and thummim of the high-priest of old, and as the shekinah from the mercy-seat between the cherubim over the ark of the covenant. He is the light which enlighteneth every man who cometh into the world, the persuasion in every invitation, the comfort in every promise, the encourager in every prediction, and the inspiration in every hope. Every sigh over a wrong is of his awakening; every smile started by a kindness springs from him; every incident that teaches some good to do or some evil to shun is his persuasive voice, and every movement toward righteousness is the impulse of his impending presence.

According to his word, God is in man, living and moving of his own good pleasure; not beyond his reach nor without him, but in him and of him, and may be recognized in every stone and star, in every glint of beauty and waft of fragrance, in every touch and tone of tenderness, and in every strain of melody and movement of intelligence. What, then, would be the use or the value of the supernatural in nature?

As to the scientific dogma of the evolution of man from monad through monkey, the New Theology is as ready to accept it as to reject it, according to the evidence; but in no event does it see the necessity of nor admit a special divine interposition to complete any stage in the process, and it is unscientific to assume it. The divine immanence is constant, and is sufficient for every evolved condition without aid from or resort to unnatural or supernatural supplementation to the uniformity of nature; and, whether evolved or not, man is consciously and practically a moral being, capable of virtue and vice, and justly censurable for evil and worthy of commendation for good.

But, more than any other, the topic which has made the New Theology most conspicuous is that which is denominated a second probation, which is yet illy conceived and variously presented. Consistent thinkers not only accept the doctrine of rewards and punishments, but hold that neither can adequately express the Divine attitude toward holiness and sin, nor man's sense of propriety and justice, unless they be eternal. They do not assume to describe the rewards or the punishments of the future, nor to know their constituents, but presume, from their appropriateness, and from the consistency in the order of divine things, that they will be similar to or identical with the peace and joy of believers, and the commotion and wretchedness of sinners on earth. From this point the New Theology shades off gradually from the Old. It holds that sin involves death or permanent disability, and that continuous sinning becomes increasingly disastrous, undermining and weakening the moral nature, until it becomes so enfeebled as hardly to be able to perform or to enjoy the pleasures of a virtuous deed, and logically terminates in the extinction of moral being. But since, according to Scripture and science, nothing is made in vain, or to be destroyed, there must be hope where there is life, and since the annihilation of any existence implies a useless act in its creation, or an error in the calculation of its author, it assumes that being, especially moral being, is an assurance of immortality, and that so long as there is a spark of vitality there is a possibility, or, according to the nature and course of things, a probability of an awakening to a higher life and its eternal development. And if, with the diminution of moral energy referred to, there is, as is claimed, an element of pain as a corollary of transgression, it is an additional evidence of the probability of reformation and growth, for suffering is not a penalty in token of disapproval, but a sign of mercy and an agency of restraint and reformation. The penalty of sin is death—an eternal disability—and the pain that accompanies it is its symptom demanding attention, and the application of curative remedies. As the pain of a burn, the gnawing of hunger, the distress of fever, are symptoms of threatened danger which indicate the localities in jeopardy, the disintegration of the tissues in process, and call for help, and disturb until relieved; so the fiery darts of sin, the cravings from spiritual inanition, and the restless ferment from corrupt desires and vicious practices, give the alarm of moral dissolution, and cry "with groanings unutterable," until the remedies are applied and the cure is effected. So that suffering, physical and spiritual, is the cry for mercy from the depths of transgression, and is the sign of hope and the assurance of a "present help in time of need," unless the desire of sufferers exceeds the measure of the divine and human compassion. If, therefore, life is continuous and pain accompanies penalty, the possibility of recovery from the pain of transgression and of a new opportunity in life must be their concomitants, and last as long as "life and thought and being." So that penalty, so long as it is accompanied with pain, is an evidence of probationary being, and there is certainly no philosophic nor scientific reason, and probably no biblical teaching, incompatible with these two principles—the continuity of life, and the remedial nature of pain; and, therefore, it may confidently be affirmed, *where there is pain there is hope.*

But probationary life is not hypothecated on continuity of life, nor on any remedial provision in life, but on the essential nature of morality. The phrase "*second probation*" is misleading, so far as it implies a continuity of condition or state. Each moral act—i. e., each deliberate act for which a moral being is responsible—completes a probationary period, so that a moral life is a succession of periods in which deliberate choice, or the acceptance or rejection of ultimate good, is expressed. Probation is, therefore, of instantaneity and not of continuity, except so far as continuity indicates a succession of moral or probationary processes; character is the tendency evoked by the last determination; virtuous life is a succession of best choices, and finite moral being and morality terminate with probation. There is a disposition in the human mind to repeat its acts, and it acquires the facility of habit by its repetitions, so that one virtuous or vicious act heralds another, but each volition determines, as it also indicates, the character, and therefore, if there be virtue in the future, it must be predicated there as here on a probationary existence, and be secured by deliberate choice. And to the objection that this *postulatum* renders the conditions of the future as uncertain as in the present, it need only be said that the ordinances of Heaven are not regulated by speculative philosophers or theologians. But why should the conditions of the future differ from those of the present? Is God variable or partial? Is not a probationary existence here wise? Could there be virtue or vice, happiness or wretchedness, without it? Could there be virtue or vice under constraint? Would obedience or disobedience that was perfunctory, or a sequence, or of habit, were it possible, be of any moral quality so as to be either pleasing or displeasing to God, or profitable or damaging to the soul? Or is there any greater probability of falling from virtue hereafter than here? But virtue is impossible anywhere without the alternative of vice; and, since the tendency to repeat is confirmed by repetition, and since virtue only accords with or is agreeable to the soul, is it not probable that the acquired taste for virtue shall continually increase until all other inclination of the soul shall cease, and virtue shall be loved for itself, and be practiced because it is so loved? And so vice can only be vice when it can be rejected. It, too, may be pursued to a habit, but it is always hostile to nature, and can never be relished; so that, since it is unnatural and disagreeable and unnecessary, it is not improbable that it will be resisted and ultimately be superseded by virtue; for will not the "evil" always "bow before the good"? This, at least, would be in accord with the order of nature, and could neither minify penalty nor reproach law, and would vindicate the divine righteousness in the creation and redemption of man, and be the fullest and the grandest exhibition of the divine wisdom and love to the intelligent universe.

To compass this end, Christian theology has resorted to purgatory, universalism, restoration, annihilation of the wicked, second probation, and other subterfuges, and has sought in scriptural teaching and in natural processes for a theodicy that would relieve the Creator from the reproach of the eternal punishment of sinners. To a greater or less extent all these schemes to rescue man from the unquenchable fire and the gnawings of the undying worm, or to justify their infliction, are evoked by shame or horror at the extreme severity of the penalty, and express the modifications which human wisdom and tenderness would interpose or substitute. They not only reproach God for inhumanity, but overlook the fact that his law could not be sanctioned nor be worthy of respect were its penalties either variable or transient.

Death—eternal disability—must follow the first and least as well as the last and greatest transgression, and the eternity of its infliction is based on sin and not on continuous sinning. But death does not end life. It is a stage in a process which marks the decay or loss experienced by a wasted moment or a neglected opportunity which never can be recovered, and the beginning of a new opportunity in life, and can be no more reproachful in its recurrence than in its incipience. The eternity of the reward and punishment is not only an expression of the sanctity of the law, but of the divine respect for it, and leads its subjects to reverence it that they may enjoy its benefits and escape its condemnations forever. So that eternal punishment is adapted to awaken pleasure and gratitude rather than shame and horror, and needs no sentimental theodicy of human contrivance to justify it or to reconcile it with divine or human nature.

The New Theology does not claim to make men better Christians, for it teaches that the divinest character is formed by striving after the best, and that no intellectual belief or formal creed can improve moral nature ; but it aims to give clearer and more rational ideas of God and his will and ways, and to present Christianity in a more attractive form and with an enlarged scope to its province. It contemplates the divine Creator and preserver with reference to his moral creation chiefly in the light of a loving Father, immanent in all the works of his hand, directing and supporting in every motion, and controlling all forces and agencies so that they shall be in harmony with his law and work together for good. It defines Christianity as that which is worthy of God and becoming to man, and accepts as Christian teaching and life everything from every source which accords with and promotes godliness. It recognizes and adores Christ as the manifestation of every conceivable attribute and desirable quality contained in the infinite Godhead, and as the only sufficient and perfect Saviour of mankind ; and it holds that faith which seeks to be possessed of the mind of Christ regenerates the heart and makes the life Christ-like, and secures salvation to mankind by the divine or Christ-like possessions it imparts. It acknowledges as acceptable worship to the true God the sincere devotion that is paid to any god, and insists that this is conformable to sound reason and sacred Scripture ; for no two devotees of pagan altar or Christian shrine conceive the same God, so that there must be as many gods as men ; and certainly any creed that does not include sincere idolatry and fetichism as acceptable forms of worship to him who is high over all, blessed for evermore, is less tolerant than Brahmanism, which teaches that they who have not discovered the highest God may worship lower gods, and also than the Supreme Vedic God who three thousand years ago declared, "Even those who worship idols worship me."

It maintains that the Christian religion appertains to the whole life, and defines it as the purpose to do God's will in everything, or "to do with our might and as unto the Lord whatsoever our hands find to do." It makes the threading of a needle as sacred as a sacrament. It seeks to do as God would do in eating and drinking, in buying and selling, in speaking and thinking, in work and play, in personal indulgences, and in administering to the needy. Everything to do is a religious duty and an opening to diviner capability and enjoyment, and anything done that is not intended to please God or to achieve the highest good is irreligious or infidel.

OUR DEBT TO INSECTS.

By GRANT ALLEN.

IT has often occurred to me as a curious fact, when I have been watching the bees and butterflies in an English meadow of a summer morning, that no one should ever yet have adequately realized (so far as I know) the full amount of human indebtedness to those bright and joyous little winged creatures. I do not mean our practical indebtedness to insects for honey and bees'-wax, silk and satin, cochineal and lacquer, or a hundred other such-like useful products: these, indeed, are many and valuable in their own way, though far less so than the tribute we draw from most of the other great classes of animal life. But there is one debt we owe them so out of all proportion to their size and relative importance in the world that it is strange it should so seldom meet with due recognition. Odd as it may sound to say so, I believe we owe almost entirely to insects the whole presence of color in nature, otherwise than green; without them our world would be wanting in more than half the beautiful objects which give it its greatest æsthetic charm in the appreciative eyes of cultivated humanity. Of course, if insects had never been, the great external features of the world would still remain essentially the same. The earth-sculpture that gives rise to mountains and valleys, downs and plains, glens and gorges, is wholly unconnected with these minute living agents; but all the smaller beauties of detail which add so much zest to our enjoyment of life and nature would be almost wholly absent, I believe, but for the long-continued æsthetic selection of the insect tribes for innumerable generations. We have all heard over and over again that the petals of flowers have been developed mainly by the action of bees and butterflies; and as a botanical truth this principle is now pretty generally accepted; but it may be worth while to reconsider the matter once more from the picturesque and artistic point of view by definitely asking ourselves, How much of beauty in the outer world do we owe to the perceptions and especially to the color-sense of the various insects?

If we could suddenly transplant ourselves from the gardens and groves of the nineteenth century into the midst of a carboniferous jungle on the delta of some forgotten Amazon or some primeval Nile, we should find ourselves surrounded by strange and somewhat monotonous scenery, very different from that of the varied and beautiful world in which we ourselves now live. The huge foliage of gigantic tree-ferns and titanic club-mosses would wave over our heads, while a green carpet of petty trailing creepers would spread luxuriantly over the damp soil beneath our feet. Great swampy flats would stretch around us on every side; and, instead of the rocky or undulating hills of our familiar Europe, we should probably see the interior country composed only of low ridges, unlifted as yet by the slow upheaval of ages into the Alps or Pyrenees of the modern continent. But the most striking peculiarity of the scene would doubtless be the wearisome uniformity of its prevailing colors. Earth beneath and primitive trees overhead would all alike present a single field of unbroken and unvarying green. No scarlet flower, golden fruit, or gay butterfly would give a gleam of brighter and warmer coloring to the continuous verdure of that more than tropical forest. Green, and green, and green, again ; wherever the eye fell it would rest alike upon one monotonous and unrelieved mass of harsh and angular verdure.

On the other hand, if we turn to a modern English meadow, we find it bright with yellow buttercups and purple clover, pink-tipped daisies and pale-faced primroses. We see the hedges white with may or glowing with dog-roses. We find the trees overhead covered with apple-blossom or scented with horse-chestnut. While in and out among the beautiful flowers flit equally beautiful butterflies—emperors, admirals, peacocks, orange-tips, and painted ladies. The green of the grassy meadow and the blue of the open sky serve only as backgrounds to show off the brighter hues of the beautiful blossoms and the insects that pay court to them incessantly.

To what is this great change in the general aspect of nature due? Almost entirely, we may now confidently conclude, to the color-sense in the insects themselves. The lovely tints of the summer flowers and the exquisite patterns on the butterfly's wings have alike been developed through the taste and the selective action of these humble little creatures. To trace up the gradual evolution of the insect color-sense and its subsequent reactions upon the outer world, we must go back to a time when neither flower nor butterfly yet existed.

In the carboniferous earth we have reason to believe that almost all the vegetation belonged to the flowerless type—the type now represented among us by ferns and horse-tails. These plants, as everybody knows, have no flowers, but only spores or naked frondlets. There were a few flowering plants it is true, in the carboniferous world, but they belonged entirely to the group of conifers, trees like the pines and cycads, which bear their seeds in cones, and whose flowers would only be recognized as such by a technical botanist. Even if some stray archaic members of the true flowering groups already existed, it is, at any rate, almost certain that they must have been devoid of those gay petals which distinguish the beautiful modern blossoms in our fields and gardens.

A flower, of course, consists essentially of a pistil or seed-producing organ, and a certain number of stamens or fertilizers. No seed can come to maturity unless fertilized by pollen from a stamen. But experience, and more especially the experiments of Mr. Darwin, have shown that plants produced from the pollen of one flower applied to the pistil of another are stronger and more vigorous than plants produced from the stamens and ovules of a single blossom. It was to obtain the benefit of this cross-fertilization in a simple form that flowers first began to exist; their subsequent development depends upon the further extension of the same principle.

The pines and other conifers, the grasses and sedges, and the forest-trees, for the most part depend upon the wind to waft the pollen of one blossom to the pistil of the next. Hence their flowers generally protrude in great hanging masses, so that the breeze may easily carry off the pollen, and that the pistils may stand a fair chance of catching any passing grain. Flowers of some such types as these were doubtless the earliest of all to be evolved, and their colors are always either green or plain brown.

But wind-fertilization is very wasteful. Pollen is an expensive product to the plant, requiring much useful material for its manufacture; and yet it has to be turned loose in immense quantities on the chance that a stray grain here and there may light upon a pistil ready for its reception. It is almost as though the American farmers were to throw their corn into the Atlantic in hopes that a bushel or two might happen to be washed ashore in England by the waves and the Gulf Stream. Under such circumstances, a ship becomes of immense importance; and Nature has provided just such ships, ready-made for the very work that was crying out to them. These ships were the yet undifferentiated insects, whose descendants were to grow into bees, rose-beetles, and butterflies.

Already, in the carboniferous world, winged insects had begun to exist. Some of these must soon have taken to feeding among the hanging blossoms of the first flowering plants. Insects are fond of the soft and nutritious pollen; and it would seem at first sight as though they could therefore be only enemies to the plants which they visited. But, as they went from flower to flower in search of food, they would carry pollen from one to the other, clinging to their heads, feet, or legs; and so would unconsciously aid in fertilizing the blossoms. Though some of the pollen would thus be eaten up, yet the saving effected by the substitution of the insect as a ship, for the old wasteful mode of dispersal by the wind, would more than compensate for the loss thus brought about. Accordingly, it would naturally happen that those flowers which most specialized themselves for fertilization by means of insects, would gain a considerable advantage over their neighbors in the struggle for existence. For this purpose, their outer leaves ought to assume a cup-like shape, instead of the open clusters of the wind-fertilized type; and their form should be directed rather to saving the pollen than to exposing it; while their efforts must chiefly be expended in attracting the insects whose visits would benefit them, and repelling all others. Those flowers which chanced to vary most in these directions would best succeed from generation to generation; and their descendants would finally become so modified as to be fitted for fertilization by insects only.

It would be needless here to allude once more to the changes in shape and arrangement thus brought about by the action of the insects. The attraction of perfume and honey, the devices of adaptation and modification, by which plants allure or detain their insect visitors, must be taken for granted, and we must pass on to our proper subject of color.

If, when insects were first beginning to visit flowers, there was any special difference by which the pollen-bearing parts could be easily distinguished from the other organs of the plant, we may be sure that it would be seized upon by the insects as a guide to the existence of food, and would so be further strengthened and developed in all future plants of the same species. Now, we have reason to believe that just such a primitive difference *does* exist between flowers, and leaves or stems; and *that* difference is one of color. Even if we look at the catkins and grass-blossoms of our own day, we see that they differ slightly in hue from the foliage of their respective plants. But it seems not improbable that color may have appeared much more frequently and abundantly in *primitive* wind-fertilized flowers than in those of our own epoch; because wind-fertilized flowers are only injured by the visits of insects, which would be attracted by bright color; and hence natural selection would tend to keep down the development of brilliant tints in them, as soon as these had become the recognized guides of the insect eye. In other words, as flowers have now split up, functionally speaking, into two great groups, the wind-fertilized and the insect-fertilized, any primitive tendency toward the production of bright leaves around the floral organs will have been steadily repressed in the one group and steadily encouraged in the other.

Did such a primitive tendency ever exist? In all probability, yes. The green parts of plants contain the special coloring-matter known as chlorophyl, which is essential to their action in deoxidizing the carbonic acid of the atmosphere. But, wherever fresh energies are being put forth, the reverse process of oxidation is going on; and in this reverse process the most brilliant and beautiful colors make their appearance. We are all familiar with these colors in autumn leaves; and we may also observe them very conspicuously in all young shoots or growing branches, especially in the opening buds of spring, the blanched heads of rhubarb or seakale, and the long sprays of a sprouting potato, grown in a dark cellar. Now, the neighborhood of the floral organs is just such a place where energies are being used up and where color is therefore likely to appear. Mr. Sorby has shown that the pigment in petals is often exactly the same as that in the very young red and yellow leaves of early spring, and the crimson foliage of autumn, in the same plant. It would be impossible to go fully here into the evidence which might be offered on this head; an immense mass of facts shows us that color is always tending to appear in the leaves which immediately surround the floral organs; and that this tendency has been strengthened by insect selection of the most conspicuous blossoms, until it has finally resulted in the brilliant corollas of such flowers as those which we now cultivate in our modern gardens.

But all this takes for granted the very fact with which we are now concerned, the existence and growth of an insect color-sense. How do we know that insects can distinguish colors at all? For otherwise all this argument must be fallacious, and the presence of bright corollas must be due to some other cause.

Of all insects, bees are the most confirmed flower-haunters, and they have undergone the greatest modification in relation to their visits in search of honey. We might expect, therefore, that bees would exhibit a distinct color-sense; and this is actually the case. Sir John Lubbock's experiments clearly prove that bees possess the power of distinguishing between red, blue, green, and yellow. Being anxious to see whether insects were really attracted by the hues of flowers, he placed slips of glass, smeared with honey, on paper of various colors; and the bees upon which he experimented soon learned to return to one particular color only, even though both the paper and the honey were occasionally transposed. Thus we have direct evidence of the clearest sort that the higher insects *do* actually perceive the difference between various colors. Nay, more, their perception in this respect appears to be closely analogous to our own; for while the bees had no difficulty in discriminating between red, orange, or yellow, and green, they did not seem to perceive so marked a distinction between green and blue. Now, this fact is very like that which we perceive to hold good with the human eye, for all of us are much more likely to confuse green and blue than any two other hues.

If, then, bees and wasps, as Sir John Lubbock has shown, and butterflies, as we may infer from other observations, *do* possess this developed color-sense, we may ask, how did they obtain it? In all probability it grew up side by side with the growth of bright-hued flowers. Just as those blossoms which exhibited the greatest tendency to display a brilliant whorl of tinted leaves, in the neighborhood of their stamens and pistils, would best succeed in attracting insects, so, in return, those insects whose eyes were most adapted for distinguishing the pink and yellow blossoms from the green foliage would best succeed in procuring food, and would thus live down their less gifted competitors.

It may reasonably be asked, How could an animal without a color-sense develop such a faculty by the aid of natural selection alone? At first sight the question seems indeed a difficult one; but it is possible, I think, to suggest a way in which it may have happened. Colors, viewed objectively, consist of ether-waves having different rates of vibration. In an eye devoid of the color-sense, all these ether-waves would doubtless set up the same sort of action in all the ends of the nerves, and would therefore produce exactly the same general sensations. But if in certain eyes there was the slightest tendency for some of the nerve-terminals to respond specially to the oscillations of one particular order, while others of the nerve-terminals responded rather to oscillations of a different order, there would be the first groundwork for the evolution of a color-sense. If this diversity of action in the nerve-ends proved of no service to the animal, it would go no further, because those individuals who possessed it would not be favored beyond those who did not. But if it proved useful, as it undoubtedly would do to flower-haunting insects, natural selection would insure its survival and its constant increase from generation to generation. Even color-blind people among ourselves can be taught by care and attention to discriminate slightly between the hues which they at first confuse; and if we were to choose out, time after time, from a color-blind race, all those individuals who were best able to see these distinctions, we should, no doubt, at last succeed in producing a perfect color-sense. This is just what natural selection seems to have done in the case of bees and butterflies.

Yet it may be urged that insects perhaps had a color-sense *before* they began to haunt flowers, and that this sense enabled them to pick out the brighter blossoms from the very beginning. Such an hypothesis would make the origin of beautiful flowers a much more simple matter; but we can hardly accept it, for a very good reason. Before the existence of flowers there was probably nothing upon which insects could exert a color-sense. Now, we know that no faculty ever comes into existence until it is practically of use to its possessors. Thus, animals which always live fixed and immovable in one place never develop eyes, because eyes would be quite useless to them; and even those creatures which possess organs of vision in their young and free state lose them as soon as they settle down for life in a permanent and unchangeable home. So, unless insects had something to gain by possessing a color-sense, they could never get one, prophetically, so to speak, against the contingency of flowers at some time or other appearing. Of course, no creature would develop such a sense merely for the sake of admiring the rainbow and the sunset, or of observing gems and shells or other such bright-hued but useless bodies. It is in the insect's practical world of food-hunting and flower-seeking that we must look for the original impulse of the color-sense.

Again, throughout the whole animal world, we see good reasons for concluding that, as a matter of fact, and apart from such deductive reasoning, only those species exhibit evident signs of a color-sense to whom its possession would be an undoubted advantage. Thus, in this very class of insects, bees, as Sir John Lubbock's experiments show us, do undoubtedly distinguish between red, orange, yellow, and green. Butterflies also are attracted by colors, and will, in particular, fly down to objects of the same hue as their own mates. Of course, bees and butterflies, always living among flowers, especially require a good sense of color; and so they quite accord with our expectation. Wasps, again, are omnivorous creatures, living partly upon animal and partly upon vegetable food. Everybody knows that they will quite impartially feast upon a piece of raw meat or upon the sunny side of a peach. Now, wasps, as Sir John Lubbock proved, can also distinguish colors; but they are somewhat less guided by them, apparently, than are bees; and this again bears out the same generalization. Ants are much more miscellaneous in their diet, they have no wings (roughly speaking), and they do not visit flowers except by the casual process of walking up the stems. Hence a color-sense would be of little or no use to them: and Sir John Lubbock's experiments seem to show that they scarcely possess one, or only possess it in a rudimentary form. Once more, moths fly about in the dusk, or quite at night, and the flowers which lay themselves out to attract them are white or pale yellow, since no others are visible in the evening. Thus a perception of red, blue, or orange would probably be useless to them: and Mr. Lowne has shown that the eyes of nocturnal insects differ from those of diurnal insects in a way closely analogous to that in which the eyes of bats and owls differ from those of monkeys and humming-birds. These differences are probably connected in both cases with an absence of special organs for discriminating colors; and we shall see a little later on that, while the day-flying butterflies are decked in crimson and orange to please the eyes of their fastidious mates, the night-flying moths are mostly dull and dingy in hue, or reflect the light only in the same manner as the night-flowering blossoms among which they seek their food. Ascending to the vertebrates, the birds are the class which live most in a world of fruits or flowers; and Mr. A. R. Wallace has pointed out that birds on the whole need to perceive color more than any other animals, because their habits require that they should recognize their food at a considerable distance. But birds possess a very large proportion of certain nerve-terminals called the cones, which are three times as numerous in their eyes as the other kind, called rods. These cones are almost universally believed to be the special organs of color-perception, and in mammals they are actually *less* numerous than the rods, which are supposed to be merely cognizant of light and shade. Nocturnal birds, such as owls, have very few cones, while nocturnal mammals have none. Again, the yellow spot in the retina, consisting almost entirely of cones, is found in all diurnal birds; but among mammals it occurs only in the fruit-eating class of monkeys, and in man. So that on the whole we may say the positive evidence justifies us in believing that a highly-developed color-sense exists only in those animals which would be decidedly benefited by its possession. And for these reasons it seems improbable that insects ever developed such a faculty until the need for it arose among the beautiful flowers.

Now that we have arrived at this theoretical conclusion, let us hark back again for a while to the reactions which the color-sense, thus aroused, produced upon the flowers which gave it birth.

We may take, as a capital example of an insect-fertilized flower, an English dog-rose. Compare this mentally with the wind-fertilized blossoms, such as grasses and catkins, and it is at once obvious that the great difference between them consists in the presence of a colored corolla. No wind-fertilized plant ever has a whorl of gay petals; and though the converse is not quite true, yet almost all insect-fertilized plants are noticeable for their brilliant tints of red, white, blue, or yellow. The structures in which these pigments reside have no function whatsoever, except that of attracting the insect eye. They are produced by the plant at an enormous physiological expense; and, if their object were not to secure the visits of insects, they would be just so much dead loss to the species. Nor is it only once that these colored corollas have been developed. They occur, quite independently, in both great divisions of flowering plants, the monocotyledons and the dicotyledons. This coincidence could hardly have happened had it not been for that original tendency which we already noticed for pink, scarlet, or orange pigments to appear in the neighborhood of the floral organs. Nor is it twice only, in all probability, that flowers have acquired bright petals through insect visits, but a thousand times over. In almost every family, insect-fertilized, self-fertilized, and wind-fertilized species are found side by side, the one with brilliant petals, the others with small, green, and inconspicuous flowers.

For comparison with the dog-rose, one could not find a better type than that common little early spring blossom, the dog's mercury. It is a wind-fertilized flower, and it does not wish to be seen of insects. Now, this mercury is a very instructive example of a degenerate green flower. For, apparently, it is descended from an insect-fertilized ancestor with bright petals; but, owing to some special cause, it has taken once more to the old wasteful habit of tossing its pollen to the wandering winds. As a consequence it has lost the bright corolla, and now retains only three green and unnoticeable perianth-pieces, no doubt the representatives of its original calyx. Almost equally instructive is the case of the groundsel, though in this case the process of degradation has not gone quite so far. Groundsel is a degenerate composite, far gone on the way of self-fertilization. No class of flowers have been more highly modified to suit the visits of insects than the composites. Hundreds of their tubular bells have been crowded on to a single head, so as to make the greatest possible attractive display; and in many cases the outer blossoms of the head, as in the common yellow ragwort, or in the daisy and the sunflower, have been flattened out into long rays, which serve as pennants or banners to catch the insect eye. They are very successful flowers, perhaps the most successful family on the whole earth. But the groundsel, for some reason of its own, has reversed the general family policy. It is rarely visited by insects, and has, therefore, apparently taken once more to self-fertilization; and a complete alteration has thus been effected in its appearance, when compared with its sister composites. Though it has not yet quite lost its yellow center blossoms, it has no rays, and its bells are almost concealed by its large and ugly green involucre. Altogether, we may say that groundsel is a composite far advanced on its way to a complete loss of the characteristic composite habits. It still receives the visits of a very few stray insects; but it does not lay itself out to court them, and it is, probably, gradually losing more and more of its winged clients from day to day. Thus we see that any flower which will benefit by insect-fertilization, whether it be a monocotyledon or a dicotyledon, high up or low down in either series, is almost sure to acquire brilliant petals; while, on the other hand, any flower which gives up the habit of relying upon insects is almost sure to lose or minimize its petals once more, and return to a state resembling in general type the catkins and grasses or the still lowlier self-fertilized types.

The same sort of conclusion is forced upon us if we look at the various organs in each flower which display the brilliant pigments. The petals are most commonly the seat of the attractive coloration, as in the dog-rose and the marsh-mallow. But in many other flowers, like the fuchsia, the calyx is also beautifully colored, so as to aid in the general display. In the tulips and other lilies, the crocus, the iris, and the daffodil, sepals and petals are all colored alike. In marvel-of-Peru and purple clematis, the petals are wholly wanting. In the common meadow-rue, it is the essential floral organs themselves which act as allurements; while, in the mesembryanthemums, the outer stamens become flattened and petal-like, so as to resemble the corolla of other flowers. In the composites, like daisies, where many blossoms are crowded on one head, the outer row of blossoms is often similarly flattened into rays which only serve the purpose of attracting insects toward the fertile flowers of the center. Nor does the coloring process stop at the regular parts of the flower alone: the neighboring bracts and leaves are often even more beautifully tinted than the flowers themselves. In the great white arums, grown in windows as Ethiopian lilies, the actual blossoms lie right inside the big sheath or spathe, and cluster round the tall yellow spike or spadix in the center: and this sheath acts the part of petals in the more ordinary flowers. Many euphorbias have very inconspicuous little blossoms, but each small colony is surrounded by a scarlet involucre which makes them some of the gayest among our hot-house plants. The poinsettia, which is so familiar a fashionable dinner-table plant, bears little yellow flowers which would not of themselves attract the eyes of insects; but it makes up for this deficiency by a large surrounding bunch of the richest crimson leaves, whose gorgeous coloring makes the tree a universal favorite with tropical bees and butterflies. The lovely bougainvillea carries the same idea one step further, for its small flowers are inclosed by three regularly arranged bracts of a delicate mauve or pink; and, when one sees a tree covered with this magnificent creeper in full blossom, it forms one of the most glorious masses of color to be found in the whole of external nature. Many tropical plants, and especially those of parasitical habit, are much given to developing these extra allurements of colored leaves, and their general effect is usually one of extreme brilliancy. From all these examples, we can draw the conclusion that color does not belong by original nature to one part of the plant rather than another; but that wherever the colored juices which result from oxidation of chlorophyl and its analogues began to show themselves, in the neighborhood of the stamens and pistil, they would attract the attention of insects, and so grow more and more prominent, through natural selection, from generation to generation, till they finally attained the present beauty of the tulip, the rose, the poinsettia, and the bougainvillea.

From this marvelous reaction of the color-sense in insects upon the vegetal world we must next pass on to its reaction upon the hues of insects themselves. For we probably owe the exquisite wings of the butterfly and the gorgeous burnished bronze of the rose-beetle to the very same sense and the very same selective action which have produced the hues of the lily and the hyacinth. What proofs can be shown that the colors of insects are thus due to sexual selection? In the first place, we have the certain fact that bees at least, and probably other insects, do distinguish and remember colors. Not only so, but their tendency to follow color has been strong enough to produce all the beautiful blossoms of our fields and gardens. Moreover, we have seen that while bees, which are flower-haunters, are guided greatly by color, wasps, which are omnivorous, are guided to a less extent, and ants, which are very miscellaneous feeders, not at all. It may be objected that insects do not care for the color apart from the amount of honey; but Mr. Anderson noticed that, when the corollas of certain flowers had been cut away, the insects never discovered or visited the flowers; and Mr. Darwin lopped off the big lower petals of several lobelia-blossoms, and found that the bees never noticed them, though they constantly visited the neighboring flowers. On the other hand, many bright-colored bells have no honey, but merely make a great show for nothing, and so deceive insects into paying them a call on the delusive expectation that they will be asked to stay to dinner. Some very unprincipled flowers, like the huge Sumatran rafflesia, thus take in the carrion-flies, by resembling in smell and appearance a piece of decaying meat. Moreover, certain insects show a preference for certain special flowers over others. One may watch for hours the visits paid by a bee or a butterfly to several dozens of one flower, say a purple lamium, in succession, passing by unnoticed the white or yellow blossoms which intervene between them. Fritz Müller mentions an interesting case of a lantana, which is yellow on the first day, orange on the second, and purple on the third. "This plant," he says, "is visited by various butterflies. As far as I have seen, the purple blossoms are never touched. Some species inserted their probosces both into yellow and into orange flowers; others, as far as I have observed, exclusively into the yellow flowers of the first day." Mr. T. D. Lilly, an American naturalist, observed that the colored petunias and morning-glories in his garden were torn to pieces by bees and butterflies in getting at the honey, while the white or pale ones were never visited. These are only a few sample cases out of hundreds, in which various observers have noted the preference shown by insects for blossoms of a special color.

Again, we may ask, Do different species of insects show different degrees of æsthetic taste? The late Dr. Hermann Müller, who specially devoted himself to the relations between insects and flowers, showed most conclusively that they do. The butterflies, which are at once the most locomotive and most beautiful of their class, appear to require larger masses of color for their attraction than any other group; and the flowers which depend upon them for fertilization are, in consequence, exceptionally large and brilliant. Müller attributes to this cause the well-known beauty of Alpine flowers, because bees and flies are comparatively rare among the higher Alps, while butterflies, which rise to greater elevations in the air, are comparatively common; and he has shown that, in many cases, where a lowland flower is adapted for fertilization by bees, and has a small or inconspicuous blossom, its Alpine congener has been modified so as to be suited for fertilization by butterflies, and has, therefore, brilliant bunches of crimson or purple blossoms. In his last work, he shows that, while bees form as many as seventy-five per cent of the insects visiting the beautiful and attractive composites, they form only fourteen per cent of those which visit the plain green and white umbellates, like the wild-carrot and fool's-parsley. Butterflies frequently visit the composites, but almost never the umbellates, which last depend mainly upon the smaller flies and other like insects. Of two small hedge-flowers (*Galium mollugo* and *G. verum*), Müller notes that they agree closely in other points, but the first is white, while the second is yellow, which, he says, renders it more attractive to small beetles. Of certain other flowers, which lay themselves out to attract wasps, Müller quaintly observes that they are obviously adapted "to a less æsthetically cultivated circle of acquaintances." So that the close studies of this accurate and painstaking naturalist led him to the conclusion that insects differ greatly from one another in their taste for color. Probably we shall be right if we say that the most æsthetic among them all are the butterflies, and next the bees—these two classes having undergone the most profound modifications in adaptation to their flower-haunting life—and that the carrion-flies and wasps bring up the rear.

Is there any evidence, however, that insects ever notice color in anything else but flowers? Do they notice it in their own mates, and use it as a means of recognition? Apparently they do, for Mr. Doubleday informed Mr. Darwin that white butterflies often fly down to pieces of white paper on the ground, mistaking them doubtless for others of their species. So, too, Mr. Collingwood notes that a red butterfly, let us say, nailed to a twig, will attract other red butterflies of the same kind, or a yellow one its yellow congeners. When many butterflies of allied species inhabit the same district, it often happens that the various kinds undergo remarkable variation in their coloring so as to be readily recognizable by their own mates. Again, Mr. Patterson noticed that certain blue dragon-flies settled in numbers on the blue float of a fishing-line, while two other species were attracted by shining white colors. On the whole, it seems probable that all insects possessing the color-sense possess also a certain æsthetic taste for colors.

Indeed, it is difficult to see how it could be otherwise. Whenever an animal exercises a faculty much, the exercise comes to have pleasant feelings attached to it; and this is especially the case with all sense-organs. Creatures which live on honey love sweet things: carnivores delight in the taste of blood. Singing birds listen with interest to musical notes: and even insects will chirp in response to a chirp like their own. So, creatures which pass all their lives in the search for bright flowers must almost inevitably come to feel pleasure in the perception of brilliant colors. This is not, as so many people seem to think, a question of relative intellectual organization: it is a mere question of the presence or absence of certain sense-centers.

But it may finally be urged that, even though insects recognize and admire colors in the mass, they would not notice such minute and delicate patterns as those on their own wings. Let us see what evidence we can collect on this head. First of all, insects have not only produced the petals of flowers, but also the special markings on those petals. Now, these markings, as Sprengel pointed out a century since, bear a constant reference to the position of the honey, and are in fact regular honey-guides. If one examines any flower with such marks upon the petals, it will be found that they converge in the direction of the nectaries, and show the bee or butterfly whereabout he may look for his dinner. Accordingly, they must have been developed by the gradual action of insects in fertilizing most frequently those flowers which offered them the easiest indication of where to go for food. Unless insects noticed them, nay more, noticed them closely and accurately, they could never have grown to their present definite correlation with the nectary, a correlation which, Mr. Darwin says, first convinced him of the reality of their function. "I did not realize the importance of these guiding marks," says Sir John Lubbock, "until, by experiments on bees, I saw how much time they lose if honey which is put out for them is moved even slightly from its usual place." In short, insects, like men, are creatures of habit. How complicated these marks sometimes become, we can see in most orchids.

Again, the attention insects pay to comparatively small details of color and form is clear enough from the *mimicry* which sometimes occurs among them. In some instances, the mimicry is intended to deceive the eyes of higher animals, such as birds or lizards, and can therefore prove nothing with regard to the senses of the insects themselves. But, in a few cases, the disguise is adopted for the sake of deceiving other insects; and the closeness of the resemblance may be accepted as good evidence of acute vision in the class so mimicked. Thus, several species of flies live as social parasites among the hives or nests of bees. These flies have acquired belts of color and patches of hair, closely imitating the hosts whose honey they steal; while their larvæ have even the ingratitude to devour the larvæ of the bees themselves. Of course, any fly who entered a bee-hive could only escape detection and condign punishment at the hands—or rather at the stings—of its inhabitants, provided it looked so like the householders as to be mistaken by them for one of the community. So any fly which showed at first any resemblance to a bee would for a while be enabled to rob with impunity: but, as time went on, the bees would begin to perceive the true nature of the intruders, and would kill all those which could be readily distinguished. Thus, only the most bee-like flies would finally survive; and the extent to which the mimicry was carried would be a rough test of the perceptive powers of the bees. Now, in these particular cases, the resemblance is so close that it would take in, not only an unpracticed human observer, but even for a moment the entomologist himself. Similar instances occur among *Mantidæ* and crickets.

And now let us apply these facts to the consideration of the problem before us. If those insects which especially haunt flowers are likely to have so acquired a color-sense and a taste for colors, and if they are capable of observing minute markings, bands, or eye-like spots, then we might naturally infer that they would exhibit a preference for the most beautifully colored and variously ornamented of their own mates. Such a preference, long continued and handed down to after-generations, would finally result in the development of very beautiful and varied colors among the flower-haunting species. We might expect, therefore, to find the most exquisite insects among those races which are most fully adapted to a diet of honey and pollen; and such I believe to be actually the case.

Before proceeding further, precautions should be taken against a misconception which has already occurred in this connection. It is not meant that bright colors will be found *only* among flower-haunters; for it may easily happen that in a few instances other causes may conspire to produce brilliant hues. Nor is it meant that *all* flower-haunters are necessarily brilliant; for it may also happen that some special need of protection will occasionally keep down the production of conspicuous tints. But what *is* meant is that brilliant colors are found with very exceptional frequency among the specially flower-haunting animals.

Butterflies are the order of insects which require the largest mass of color to attract them, and which seem to possess the highest æsthetic sensibility. It is hardly necessary to say that butterflies are also the most beautiful of all insects; and are, moreover, noticeable for the most highly developed ornamental adjuncts. Those butterflies make the best matches in their world of fashion which have the brightest crimson on their wings or the most exquisite gloss in their changeful golden scales. With us, an eligible young man is too often a young man with a handsome estate in the country, and with no other attractions mental or physical. Among insects, which have no estates, an eligible young butterfly is one with a peculiarly deep and rich orange band upon the tip of his wings. Thus the cumulative proof of the æsthetic superiority of butterflies seems well-nigh complete.

If we examine the lepidoptera or butterfly order in detail, we shall find some striking conclusions of the same sort forced upon us. The lepidoptera are divided into two great groups, the moths and the butterflies. Now, the moths fly about in the dusk or late at night; the flowers which attract them are pale, lacking in brilliancy, and, above all, destitute of honey-guides in the shape of lines or spots; and the insects themselves are generally dark and dingy in coloration. Whenever they possess any beauty of color, it takes the form of silvery scales which reflect what little light there may be in the gray gloaming. The butterflies, on the other hand, fly by day, and display, as we know, the most beautiful colors of all insects. Here we must once more recall that difference between the structure of the eye in nocturnal and diurnal species which Mr. Lowne has pointed out. Nor is this all. While most moths are night-fliers, there are a few tropical genera which have taken to the same open daylight existence as the butterflies. In these cases, the moths, unlike their nocturnal congeners, are clad in the most gorgeous possible mixtures of brilliant metallic colors.

Other instances of like kind occur in other orders. Thus, among the beetles, there is one family, the rose-chafers, which has been specialized for flower-haunting; and these are conspicuous for the beauty of their coloring, including a vast number of the most brilliant exotic species. Their allies, the common cock-chafers, however, which are not specialized in the same manner, are mere black and inconspicuous insects. So among the flies: most of the omnivorous families are dull and ugly; but several of the flower-haunting tribes are adorned with brilliant colors, and live upon honey. In fact, an immense majority of the brightest insects are honey-suckers, and seem to have derived their taste for beautiful hues from the nature of the objects among which they seek their food.

There is one striking and obvious exception, however, which has doubtless already suggested itself to the minds of readers. I mean the bees. These are the most flower-loving of all insects, and yet they are comparatively plain in their coloration. We must remember, however, that the peculiar nature of the commonwealth among the social bees prevents the free action of the selective preference by which we account for the brilliancy of all other flower-haunting species. The queen or mother bee is a prisoner for life; her Majesty's domestic arrangements are all made for her by the state; she does not herself seek honey among flowers, and those bees which do so have no power of transmitting their tastes to descendants, as they live and die mere household drudges. On the other hand, the solitary bees are in many cases exquisitely colored, as we might expect from their power of free choice; and one flower-haunting family of the same order, the *Chrysidæ*, are aptly compared to the humming-birds in the richness of their coloring.

One more peculiarity of great interest must also be noted. It appears that many insects have two sets of colors, seemingly for different purposes; the one set protective from the attacks of enemies, the other set attractive to their own mates. Thus several butterflies have the lower side of their wings colored like the leaves or bark on which they rest, while the upper sides are rich with crimson, orange, and gold, which gleam in the bright sunlight as they flit about among their fellows. Butterflies, of course, fold their wings with the under side outward. On the other hand, moths, which fold their wings in the opposite manner, often have their upper surfaces imitative or protective, while the lower sides are bright and beautiful. One Malayan butterfly, the *Kallima paralecta*, has wings of purple and orange above, but it exactly mimics dead foliage when its vans are folded; and, as it always rests among dry leaves, it can hardly be distinguished from them, as it is even apparently spotted with small fungi. In these and many other cases one can not help believing that, while imitative coloring has been acquired for protective purposes, the bright hues of the concealed portion must be similarly useful to the insect as a personal decoration.

It would seem, then, that we owe half the loveliest objects in our modern world to the insect color-sense. It is the bee and the butterfly which have given us the gorgeous orchids and massive creepers of the tropics, the gentians and rhododendrons of the Alps, the camellias and heathers of our conservatories, the may and primroses of our

English meadows. To the same primitive taste, exerted in a slightly different direction, are due the gilded wings of Brazilian moths, and the exquisite tints of our own ruby or sapphire colored summer insects. The beauty and the glory of the world are not for the eyes of man alone; they appeal equally to the bee and the butterfly, to the bird and the child. To some people it strangely seems a nobler belief that one animal only out of all the earth enjoys and appreciates this perpetual pageant of natural loveliness; to me it appears, on the contrary, a prettier and more modest creed, as well as a truer one, that in those higher and purer delights we are but participants with the vast mass of our humbler dumb fellow-creatures.—*Gentleman's Magazine.*

THE FRUITS OF MANUAL TRAINING.

By Professor C. M. WOODWARD, Ph. D.,
WASHINGTON UNIVERSITY, ST. LOUIS.

THE object of this paper is to consider directly the fruits of manual training. By manual training I do not mean merely the training of the hand and arm. If a school should attempt the very narrow task of teaching only the manual details of a particular trade or trades, it would, as Felix Adler says, violate the rights of the children. It would be doing the very thing I have always protested against. That, or very nearly that, is what is done in the great majority of European trade-schools. They have no place in our American system of education.

The word "manual" must, for the present, be the best word to distinguish that peculiar system of liberal education which recognizes the manual as well as the intellectual. I advocate manual training for all children as an element in general education. I care little what tools are used, or how they are used, so long as proper habits (morals) are formed, and provided the windows of the mind are kept open toward the world of *things* and *forces*, physical as well as spiritual.

We do not wish or propose to neglect or underrate literary and scientific culture; we strive to include all the elements in just proportion. When the manual elements which are essential to a liberal education are universally accepted and incorporated into American schools, the word "manual" may very properly be dropped.

I use the word "liberal" in its strict sense of "free." No education can be "free" which leaves the child no choice, or which gives a bias against any honorable occupation; which walls up the avenues of approach to any vocation requiring intelligence and skill. A truly liberal education educates equally for all spheres of usefulness; it furnishes the broad foundation on which to build the superstructure of a happy, useful, and successful life. To be sure, this claim has been made for the old education, but, the claim is not allowed. The new education has the missing features all supplied. The old education was like a two-legged stool, it lacked stability; the new education stands squarely on three legs, and it is steady on the roughest ground.

I shall be better understood if I briefly outline my idea of the features of a manual-training school: Boys from fourteen to eighteen years of age are admitted on examination. The grade is about that of a high-school. The course covers three years. The programme of every day includes three recitations (mathematics, language, and science), one hour of drawing, and two hours of shop-work—making a session, exclusive of lunch-time, of six hours. The order in which these exercises come varies in different divisions. The shops and shop-instructors are generally occupied during school-hours. In each subject taught the instruction is progressive and thorough. Mathematics begins with arithmetic and ends with trigonometry. Language may be English literature and composition, history and political economy; or Latin, or French. Science, beginning with Huxley's "Introductory Primer," runs through botany, physical geography, elementary physics, mechanics, and chemistry. Drawing is free-hand and mechanical, projection and "model," geometric, technical, and ornamental.

The shop-work runs impartially through the range of bench, lathe, and pattern work in wood; forging, brazing, and soldering metals; bench, lathe, planer, and drill work in iron, brass, and steel. The aim is to make every exercise in every branch disciplinary—intellectually and morally fruitful. With the exception of the choice of Latin and French, there is no option in the course.

I claim as the fruits of manual training, when combined, as it always should be, with generous mental and moral training, the following:

1. Larger classes of boys in the grammar and high schools; 2. Better intellectual development; 3. A more wholesome moral education; 4. Sounder judgments of men and things, and of living issues; 5. Better choice of occupations; 6. A higher degree of material success, individual and social; 7. The elevation of many of the occupations from the realm of brute, unintelligent labor, to one requiring and rewarding cultivation and skill; 8. The solution of "labor" problems. I shall touch briefly on each of these points:

1. Boys will stay in School longer than they do now.—Every one knows how classes of boys diminish as they approach and pass through the high-school. The deserters scale the walls and break for the shelter of active life. The drill is unattractive, and, so far as they can see, of comparatively little value. There is a wide conviction of the inutility of schooling for the great mass of children beyond the primary grades, and this conviction is not limited to any class or grade

of intelligence. Wage-workers we must have, and the graduates of the higher grades are not expected to be wage-workers. According to the report of the President of the Chicago School Board, about one and one eighth per cent of the boys in the public schools are in the high-schools. From his figures it appears that, if every boy in the Chicago public schools should extend his schooling through a high-school, the four classes of the high-schools would contain some nine thousand boys; in point of fact, they have about four hundred.

Superintendent Hinsdale, of Cleveland, says, "Of one hundred and eight pupils (boys and girls) entering the primary school, sixty complete the primary, twenty finish the grammar, four are found in the second class of the high, and one graduates from the high-school." In St. Louis the average age at which pupils withdraw from the public schools is thirteen and a half years. Now, I doubt if any reflecting person would consider it an unmixed good if every boy in the city should go through the high-school as it is at present conducted. Under the circumstances supposed all would probably admit that some change in the character of the instruction would be necessary.

From the observed influence of manual training upon boys and indirectly upon the parents, I am led to claim that when the last year of the grammar and the high schools include manual training, they will meet a much wider demand; that the education they afford will be really more valuable; and, consequently, that the attendance of boys will be more than doubled. Add the manual elements with their freshness and variety, their delightful shop exercises, their healthy intellectual and moral atmosphere, and the living reality of their work, and *the boys will stay in school.* Such a result would be an unmixed good. I have seen boys doing well in a manual-training school who could not have been forced to attend an ordinary school. If the city of Boston shall carry out this year, as I hope it will, Superintendent Seaver's plan for a public manual-training school for three hundred boys, there will be, in my judgment, one thousand applications for admission during the first three years.

2. Better Intellectual Development.—I am met here with the objection that I am aiming at an impossibility; that, if I attempt to round out education by the introduction of manual training, to develop the creative or executive side, I shall certainly curtail it of elements more valuable still; that the educational cup is now full; and that, if I pour in my gross material notions on one side, some of the most precious intellectual fluid will certainly flow out on the other.

Now, I deny that the introduction of manual training does of necessity force out any essential feature of mental and moral culture. The cup may be, and probably is, full to overflowing, but it is a shriveled and one-sided cup. It is as sensitive and active in its own defense as are the walls of the stomach, which, when overfed with ill-assorted food, contracts, rebels, and overflows, but which expands and readily digests generous rations of a varied diet. Did you ever see one whose mind was nauseated with spelling-books, lexicons, and grammars, and an endless hash of words and definitions? And did you, in such a case, call in the two doctors, Johann Pestalozzi and Friedrich Froebel? And did you watch the magic influence of a diet of *things* prescribed by the former, and a little vigorous practice in *doing*, in the place of *talking*, under the direction of the latter?

The students of a well-conducted manual-training school are intellectually as active and vigorous as in any high-school. Nay, more, I claim, and I have had good opportunity to observe the facts, that even on the intellectual side the manual-training boy has a decided advantage. I have been in charge of both kinds of school, and I know whereof I speak. The education of the hand is the means of more completely and efficaciously educating the brain. Manual dexterity is but the evidence of a certain kind of mental power; and this mental power, coupled with a familiarity with the tools the hands use, is doubtless the only basis of that sound, practical judgment and ready mastery of material forces which always characterize those well fitted for the duties of active, industrial life.

I go a step further. When the limit of sharp attention and lively interest is reached, you have reached the limit of profitable study. If you can hold the attention of a class but ten minutes, it is worse than a waste of time to make the exercise fifteen. The weary intellects roll themselves up in self-defense, and suffer as patiently as they can, but the memory of those moments of torment lingers and throws its dreadful shadow over the exercise as it comes up again on the morrow; and how automatically, as these over-taught children take their places again, do they begin to roll themselves up into an attitude of mental stupidity! Intellectual growth is not to be gauged by the length or number of the daily recitations. I firmly believe that in most of our schools there is too much sameness and monotony; too much intellectual weariness and consequent torpor. Hence, if we abridge somewhat the hours given to books, and introduce exercises of a widely different character, the result is a positive intellectual gain. There is plenty of time if you will but use it aright. Throw into the fire those modern instruments of mental torture—the spelling and defining books. Banish English grammar, and confine to reasonable limits geography and word-analysis. Take mathematics, literature, science, and art, in just proportion, and you will have time enough for drawing and the study of tools and mechanical methods.

Manual exercises, which are at the same time intellectual exercises, are highly attractive to healthy boys. If you doubt this, go into the shops of a manual-training school and see for yourselves. Go, for instance, into our forging-shop, where metals are wrought through the agency of heat. A score of young Vulcans, bare-armed, leather-aproned, with many a drop of honest sweat and other trade-marks of toil, stand up to their anvils with an unconscious earnestness which shows how much they enjoy their work. What are they doing? They are using brains and hands. They are studying definitions, in the only dictionary which really defines the meaning of such words as "iron," "steel," "welding," "tempering," "upsetting," "chilling," etc. And, in the shop where metals are wrought cold (which, for want of a better name, we call our machine-shop), every new exercise is like a delightful trip into a new field of thought and investigation. Every exercise, if properly conducted, is both mental and manual. Every tool used and every process followed has its history, its genesis, and its evolution.

I have been speaking of the shops of the manual-training school, not of the ordinary factory. In the latter everything is reduced as much as possible to a dull routine. Intellectual life and activity are not aimed at. The sole object of the factory is the production of articles for the market. In a manual-training school, on the other hand, everything is for the benefit of the boy; he is the most important thing in the shop; *he is the only article to be put upon the market.* No one can learn from a book the true force of technical terms and definitions, nor the properties of materials. All descriptive words and names must base their meaning upon our own consciousness of the things they signify. The obscurities of the text-books (often doubly obscure from the lack of proper training on the part of the authors, who describe processes they never tried, and objects they never saw) vanish before the steady gaze of a boy whose hands and eyes have assisted in the building of mental images.

Then, again, the habit of clear-headedness, of precision in regard to the minor details of a subject, which is absolutely essential in the shop—an exact and experimental knowledge of the full force of the words and symbols used—stretches with its wholesome influence into the study of words and the structure of language. As Felix Adler says, the doing of one thing well is the beginning of doing all things well. I am a thorough disbeliever in the doctrine that it is ever educationally useful to commit to memory words which are not understood. The memory has its abundant uses, and should be carefully cultivated; but when it usurps the place of the understanding, when it beguiles the mind into the habit of accepting the images of words for the images of the things the words stand for, then the memory becomes a positive hindrance to intellectual development.

"Manual training is essential to the right and full development of the human mind, and therefore no less beneficial to those who are not going to become artisans than to those who are. . . . The workshop method of instruction is of great educational value, for it brings the learner face to face with the facts of nature; his mind increases in knowledge by direct personal experience with forms of matter and manifestations of force. No mere words intervene. The manual exercises of the shop train mental power rather than load the memory; *they fill the mind with the solid merchandise of knowledge, and not with its empty packing-cases.*"—(*Professor E. P. Seaver, Boston.*)

3. A more Wholesome Moral Education.—The finest fruit of education is character; and the more complete and symmetrical, the more perfectly balanced the education, the choicer the fruit.

To begin with, I have noted the good effect of *occupation.* The programme of a manual-training school has something to interest and inspire every boy. The daily session is six full hours, but I have never found it too long. The school is not a bore, and holidays, except for the name of the thing, are unpopular. I have been forced to make strict rules to prevent the boys from crowding into the shops and drawing-rooms on Saturdays and after school-hours. There is little tendency, therefore, to stroll about, looking for excitement. The exercises of the day fill the mind with thoughts pleasant and profitable, at home and at night. A boy's natural passion for handling, fixing, and making things is systematically guided into channels instructive and useful, as parents freely relate.

Again, success in one branch or study (shop-exercises are marked like those of the recitation-room) encourages effort in others, and the methods of the shop affect the whole school. Gradually the students acquire two most valuable habits which are certain to influence their whole lives for good—namely, precision and method. As Professor Runkle says, "Whatever cultivates care, close observation, exactness, patience, and method, must be valuable training and preparation for all studies and all pursuits."

Dr. Adler has pointed out, with great force and elegance, the influence of the exercises of the shop upon the formation of character. This influence, he holds, will be "nothing short of revolutionary, inasmuch as it will help to overthrow many of the impure conceptions that prevail at the present day." The tasks we set are not to be judged by commercial standards; our standard is one hundred per cent; the articles we make are not to be sold; they have no pecuniary value; they are merely typical forms; their worth consists in being true, or in being beautiful, as the case may be.

The manual-training school, when well conducted, seems to me to furnish to its pupils just the opportunity which Walter Scott, in "Waverley," says that his young hero was losing forever—"the opportunity of acquiring habits of firm and assiduous application; of gaining the art of controlling, directing, and concentrating the powers of his mind for earnest investigation—an art far more essential than even that intimate acquaintance with classical learning which is the primary object of study" (at school).

4. Sounder Judgments of Men and Things.—The proverbially poor judgments of scholars have led to the popular belief that theory is one thing and practice a very different thing; that theoretically a

thing is one way, practically another. The truth is, that correct theory and practice agree perfectly. If in his theory one leaves out a single element of the problem, or fails to give each its due weight, his theory is false. The school-men have been so accustomed to living in an ideal world, the world of books and books only, where they have found only ideal problems, and they have been so ignorant of the real world and the conditions of real problems, that their solutions have very generally been false.

A harmonious culture develops common sense, and common sense is at the basis of good judgment. We aim to raise that kind of fruit. Boys who put every theory to the practical test, who know something about what the idealists call "the total depravity of inanimate things," who probe and test every statement and appliance, with whom authority and tradition, the bane of too much "book-learning," have little influence, and who therefore are apt to take things at their true value, are fitted to focus correctly upon the problems of real life.

We hear much, and with good reason, of the value of directive intelligence. To be a director one must have good judgment. He who would successfully direct the labor of other men must first learn the art of successful labor himself; and he who would direct a machine properly must understand the principles of its construction, and be personally skilled in the arts of preservation and repair. Dr. Harris, therefore, tells but a half-truth when he says that "The new discovery (the invention of a new tool) will make the trade learned to-day, after a long and tedious apprenticeship, useless to-morrow. The practical education, therefore, is not an education of the hand to skill, but of the brain to directive intelligence. The educated man can learn to direct a new machine in three weeks, while *it requires three years to learn a new manual labor*."—("Education," May–June, 1883.)

This last sentence is not clear to me. Somehow it seems to imply that the man who learns to run a machine should be more intelligent and requires more education than the man who made it. As to "directive intelligence," I respectfully submit the following as a substitute for the dictum of Mr. Harris: "The practical education is, therefore, an education of the hand to skill and of the brain to intelligence. The combination will give the highest directive power."

5. Better Choice of Occupations.—This point is one of the greatest importance, for out of it are the issues of life. An error here is often fatal. But to choose without knowledge is to draw as in a lottery, and when boys know neither themselves nor the world they are to live in, and when parents do not know their own children, it is more than an even chance that the square plug will get into the round hole.

Parents often complain to me that their sons who have been to school all their lives have no choice of occupation, or that they choose to be accountants or clerks, instead of manufacturers or mechanics.

These complaints are invariably unreasonable; for how can one choose at all, or wisely, when he knows so little!

I confidently believe that the development of the manual elements in school will prevent those serious errors in the choice of a vocation which too often wreck the fondest hopes. It is not assumed that every boy who enters a manual-training school is to be a mechanic; his training leaves him *free*. No pupils were ever more unprejudiced, better prepared to look below the surface, less the victims of a false gentility. Some find that they have no taste for manual arts, and will turn into other paths—law, medicine, or literature. Great facility in the acquisition and use of language is often accompanied by a lack of either mechanical interest or power. When such a bias is discovered the lad should unquestionably be sent to his grammar and dictionary rather than to the laboratory or draughting-room. On the other hand, decided aptitude for handicraft is not unfrequently coupled with a strong aversion to and unfitness for abstract and theoretical investigations. There can be no doubt that, in such cases, more time should be spent in the shop, and less in the lecture and recitation room. Some who develop both natural skill and strong intellectual powers will push on through the polytechnic school into the professional life, as engineers and scientists. Others will find their greatest usefulness, as well as highest happiness, in some branch of mechanical work, into which they will readily step when they leave school. All will gain intellectually by their experience in contact with things. The grand result will be an increasing interest in manufacturing pursuits, more intelligent mechanics, more successful manufacturers, better lawyers, more skillful physicians, and more useful citizens.

In the past comparatively few of the better educated have sought the manual occupations. The one-sided training of the schools has divided active men into two classes—those who have sought to live by the work of their own hands, and those who have sought to live by the work of other men's hands.

Hitherto men who have aimed to cultivate their minds have neglected their hands; and those who have labored with their hands have found no opportunity to specially cultivate their brains. The crying demand to-day is for intellectual combined with manual training. It is this want that the manual-training school aims to supply.

6. Material Success for the Individual and for the Community.—Material success ought not to be the chief object in life, though it may be sought with honor, and worthily won; in fact, success would appear to be inevitable to one who possesses health and good judgment, and who, having chosen his occupation wisely, follows it faithfully. This point might, then, be granted as a corollary to those already given and without further argument; but two points deserve special mention:

I have said that the only article our shops put upon the market is *evenly-trained boys;* I now wish to add that the article is a new one. You can not determine its value by invoicing the boys who, in the past, have drifted without proper education and without intelligent choice into shops and offices. I do not claim that manual training will change a dull boy into a bright one, or a bad boy into a good one. It is by no means a sovereign remedy for all the evils that boys are heir to; but it will give the dull boy a chance to become less dull, and the bright one a chance to retain his brilliancy. We have had some bad boys, but I honestly think their badness was less alluring and corrupting and hopeless than it would have been among boys less absorbed in their work. We have had some plain cases of failure, but they had failed everywhere else. It is not safe to reason that, because a boy can not succeed anywhere else, he must succeed in the shop. Brains are as essential to a good mechanic as to a good soldier or a good orator. Undoubtedly, more than half of our boys will find uses for their manual training, and they will have an immense advantage over the untrained boys. They are all fair draughtsmen. They have a wide acquaintance with hand and machine tools, and considerable skill in their use. They have an experimental knowledge of the properties of common materials; of the effects of heat, and the nature of friction. They have analyzed mechanical processes and been taught to adapt means to ends. Such boys will never become mere machine-men. They will never be content to put their brains away like a piece of ornamental toggery for which they have no daily use. If you wish boys to become narrow, unreflecting, bigoted, and helpless, when their machines break down and when they are thrown upon their own resources, don't send them to a manual-training school, for you will surely be disappointed.

Our graduates have been out of school less than a year, but I have seen enough to justify me in saying that their chances of material success are unusually good. As workmen, they will soon step to the front; as employers and manufacturers, they will be self-directing and efficient inspectors. They will be little exposed to the wiles of incompetent workmen.

On the other hand, communities will prosper when their young men prosper. This is the *dynamic age;* the great forces of Nature are being harnessed to do our work, and we are just beginning to learn how to drive. Invention is in its youth, and manual training is the very breath of its nostrils.

7. THE ELEVATION OF MANUAL OCCUPATIONS FROM THE REALM OF BRUTE, UNINTELLIGENT LABOR TO ONE REQUIRING AND REWARDING CULTIVATION AND SKILL.—A brute can exert brute strength; to man alone is it given to invent and use tools. Man subdues Nature and develops art through the instrumentality of tools. Says Carlyle: "Nowhere do you find him without tools; without tools he is nothing; with tools he is all." To turn a crank, or to carry a hod, one needs

only muscular power. But to devise and build the light engine, which, under the direction of a single intelligent master-spirit, shall lift the burden of a hundred men, requires a high degree of intelligence and manual skill. So the hewers of wood and the drawers of water are in this age of invention replaced by saw and planing mills, and water-works requiring some of the most elaborate embodiments of thought and skill. Can any one stand beside the modern drawers of water, the mighty engines that day and night draw from the Father of Waters the abundant supply of a hundred thousand St. Louis homes, and not bow before the evidence of "cultured minds and skillful hands," written in unmistakable characters all over the vast machinery?

In like manner every occupation becomes ennobled by the transforming influence of thought and skill. The farmer of old yoked his wife with his cow, and together they dragged the clumsy plow or transported the scanty harvest. Down to fifty years ago the life of a farmer was associated with unceasing, stupefying toil. What will it be when every farmer's boy is properly educated and trained? Farming is rapidly becoming a matter of horse-power, steam-power, and machinery. Who, then, shall follow the farm with honor, pleasure, and success? Evidently only he whose cultivated mind and trained hands make him a master of the tools he must use. With his bench and sharp-edged tools, with his forge and his lathe, he will "direct" and sustain his farm-machinery with unparalleled efficiency.

Some appear to think that the continued invention of tools and new machines will diminish the demand for men skilled in mechanical matters; but they are clearly wrong. True, they will diminish the demand for *unintelligent* labor—and some prominent educators, who take ground against manual training, have apparently no idea of labor except unintelligent labor. If there are more machines, there must be more makers, inventors, and directors. Not one useful invention in ten is made by a man who is not a skilled mechanic. But, as I have said, the mechanics have suffered from a one-sided education. They have paid too little attention to science and the graphic arts. Hence every manual pursuit will become elevated in the intellectual scale when mechanics are broadly, liberally trained.

Undoubtedly the common belief is, that it requires no great amount of brains or intelligence to be a mechanic; and those who go through the schools are not expected by their teachers to be mechanics. Every bright farmer's boy, every gifted son of a mechanic, if he but stay in school, is sure to be stolen away from the occupation of his father and led into the ranks of the "learned professions."

Professor Magnus calls attention to the fact that the promising pupils of the elementary public schools of London, who receive scholarships on account of unusual abilities, are, from a lack of secondary schools suited to improve directly the condition of the artisan classes, always sent on through the classical schools to the Universities of Oxford and Cambridge, and trained to professional or literary careers. Such a result does not react favorably upon the artisan class. The scholarship boys return no more to their homes, and the gulf is widened between the spheres from which they came and those to which they go. Says Magnus, "I very much doubt whether the nation gains much by sending these children into the already overcrowded paths that are open to the university students." This loss of the best minds and the lack of the results of a generous education do much to keep down the estimation in which the working-classes are held, and throw the elements of society out of their proper balance.

Here is where the influence of manual training will be most beneficial. It will bring into the manual occupations a new element, a fairly educated class, which will greatly increase their value, at the same time that it gives them new dignity.

8. The Solution of Labor Problems.—Finally, I claim that the manual-training school furnishes the solution of the problem of labor *vs.* capital. The new education will give more complete development, versatility, and adaptability to circumstance. No liberally trained workman can be a slave to a method, or depend upon the demand for a particular article or kind of labor. It is only the uneducated, unintelligent mechanic who suffers from the invention of a new tool. The thoroughly trained mechanic enjoys the extraordinary advantage of being able, like the well-taught mathematician, to apply his skill to every problem ; with every new tool and new process he rises to new usefulness and worth.

The leaders of mobs are not illiterate, but they are narrow, the victims of a one-sided education, and their followers are the victims of a double one-sidedness. Give them a liberal training, and you emancipate them alike from the tyranny of unworthy leaders and the slavery of a vocation. The sense of hardship and wrong will never come and bloody riots will cease when working-men shall have such intellectual, mechanical, and moral culture that new tools, new processes, and new machines, will only furnish opportunities for more culture, and add new dignity and respect to their calling.

ARE SCIENCE AND ART ANTAGONISTIC?

By M. M. GUYAU.

A STORY is told of the poet Keats, that once after a dinner at Haydon's, the English painter, he raised his glass and proposed as a toast, "Confusion to the memory of Newton!" When asked his reason for offering this singular sentiment, the poet replied, "Because he destroyed the poetry of the rainbow with his prism."

Is the poetry of things really destroyed by a scientific acquaintance with them? Does all poetry in a sense resemble that many-colored, light-embroidered band which the ancients deified, and whose wholly geometrical and earthly texture Newton laid bare? Pascal said there was no difference between the poet's trade and the embroiderer's; Montesquieu said the poet's business was "to overload reason and nature with fine fancies, as we used to bury women under their dress-trimmings." Voltaire regarded such expressions as only jests, though malicious ones; but they appear to a considerable number of the scientific men and thinkers of the present day to embody the exact expression of a truth. Poetry, which, in the seventeenth and eighteenth centuries, had the majority of the good people on its side, has now, they tell us, only the minority. Science is the great obsession of our age; we all render to it, often unconsciously, a sort of worship, and can not help feeling a kind of scorn for poetry. Mr. Spencer compares Science to the humble Cinderella, who was hidden so long in the chimney-corner, while her proud sisters displayed their tinsels in everybody's eyes. Now Cinderella is taking her turn; "and some day Science, declared the best and the fairest, will reign as sovereign." M. Renan predicts a time "when the great artists will be an antiquated affair, nearly useless, while the value of the scientific man will be more and more appreciated." M. Renan has also expressed regret that he did not himself become a scientific man instead of being a *dilettante* in erudition. Who can say that Goethe, if he had been born in the present age, would not have preferred to devote himself entirely to the natural sciences; or that Voltaire would not have applied himself more to mathematics, in which he showed some force; or that Shakespeare would not have engaged in a more weighty occupation of his psychological powers than the construction of his dramas of human paltriness? Darwin's grandfather devoted a part of his talent to writing poor poems; the grandson, if he had been born a hundred years earlier, might have done the same; but Charles Darwin, in the spirit of the age in which he lived, instead of a poem of gardens, gave us the scientific epic of natural selection. Poems die with their languages, and poets can hope for their works "only an evening of life in the hearts of lovers"; the canvases of painters wear out, and, in a few hundred years, Raphael will be nothing but a name; statues and monuments fall into dust; only thought seems to live, and he who adds a thought to the stores of the human mind may live by its means as long as mankind itself. Must we believe that imagination and feeling are not as vital as thought, and that art must finally give way to science? The question is worthy of consideration, for it concerns the destiny of human genius and the shapes it is to assume in the future.

The writers who predict that poetry and the arts will gradually disappear rest upon a number of facts, some of which are borrowed from physiology and history, and others from psychology. We will inquire, first, what the natural and historical sciences teach us concerning the medium in which art can live.

Art, to reach its full development, requires around the artist and within him a cultivation of beauty of which the Greeks have given an example. This people had, for purity of form, for the harmonious proportion of the limbs, and for beautiful nudities, a love that went to the verge of adoration; and beauty was, in their eyes, invested with something sacred. This worship of beauty was revived at the renascence. In our days, on the other hand, strength and beauty of body are not the ideal. Many things seem to show that a too exclusive preoccupation with pleasing forms, as well as with ornaments and decorations, are a sign by which we can recognize primitive conditions of civilization. With those modern people who are still in an inferior grade of civilization, as with the Arabs, the male sex itself displays much coquetry, and seeks to please especially with its strength and physical beauty, its vesture, and its adornments. Civilization gradually destroys these primitive instincts, which have been, however, according to Mr. Darwin and Mr. Spencer, the germ of art. The man of our days does not care whether he has, under the convenient and ungraceful vestments that hide him, a well-developed torso and vigorous muscles. Coquetry survives and will doubtless continue to survive with women, but it too often tends to stray from its purpose, which is to bring out the beauty of the members. Women, who ought, more than all other persons, to endeavor to preserve pure and correct forms, take a thousand devices to hinder the development of their bodies and the circulation of their blood. So, not only the ancient culture, but beauty itself, seems to be falling into decadence, and the principal object of the arts is tending to disappear.

Many circumstances in our artificial modern life are combining to produce a tendency to diminution of stature and an augmentation of bodily deformities; among them the constantly increasing division of labor, under which the physical systems of workmen become developed in a single direction only, and too often cramped in other directions; the efforts of philanthropic science to preserve the sick and deformed, and help them propagate their race; the agglomeration of multitudes in cities; conscription, taking the most vigorous men for the army; and the dissipations of society and fashionable life, are producing a kind of reverse selection that may encourage infirmity and ugliness. The brain is becoming more and more the pre-eminently active organ. According to some anthropologists, the nervous system of the civilized man is thirty per cent larger than that of the savage, and it is destined to go on increasing at the expense of the muscular system. It is not probable, however, that this process will go so far as to result in permanent injury, for with the expanding development of the brain will go an increased quickness in detecting whatever evils may threaten the rest of the system and readiness to apply the remedies. It is one of the prerogatives of science to cure the wounds which itself inflicts, and it will do this in the present case by means of a better regulated education, through a more complete understanding of hygiene and gymnastics, and generally by a more methodical application of the laws that regulate the harmonious development of the organs. While there is doubtless something admirable in the motionless purity of forms, in proportion, and in the perfect adaptation of the organs to their functions which constitute plastic beauty, supreme and really poetic beauty, nevertheless, lies pre-eminently in expression and movement. To the modern age, the face is still the most beautiful part of the man, and that is constantly tending, by the development of the nervous system, of intelligence and morality, to become more expressive. By virtue of the mutual dependence of the organs, the man of future ages, if the development of his nervous system continues in a manner compatible with his general vigor, will wear in his very physiognomy the steadily brightening reflection of intelligence, "and infinity of thought in the depth of his eyes." Even if the body is less sturdy and less handsome than the bodies of the athletes of Polycletus and the fleshy giants of Rubens, the head will have acquired a superior beauty. Are a brow radiant with living thought and eyes through which the soul is shining of no value from the plastic point of view? Intelligence ultimately impresses its mark upon the whole body, which, if less fitted under its predominance for the combat or the race, gains nevertheless a beauty peculiarly its own. Beauty, in short, will be intellectualized, and the same will be the case with art. Now, if modern art and poetry are to live chiefly by expression; if the head and thought are already assuming an increasing importance in the works of our epoch; if movement, the visible sign of thought, is finally to animate everything with it, as in the works of Michael Angelo and Puget—will art be destroyed in undergoing the transformation? We might say, borrowing the terminology of contemporary science, that the ancients were mainly acquainted with "static" art, while modern art, with its movement and expression, is "dynamic." Following in its course the evolution of human beauty, art tends to rise, as it were, from the limbs to the face and the brain.

History also, as well as physiology, has furnished some specious arguments against the future of art. The development of particular arts seems frequently connected with particular manners and a particular social condition. M. Taine believes that many arts now languishing are threatened with starvation in the future. M. Renan says the reign of sculpture was over when men ceased to go half naked. Epic poetry disappeared when the age of individual heroism passed away, and can not coexist with artillery. Every art, except music, is thus dependent upon a past state; and music, too, which may be regarded as the art of the nineteenth century, will some day have run its course.

The art most compromised in modern times is sculpture. Victor Cousin said, before M. Renan, that there could be no "modern sculpture" with the manners of our days. Admitting that sculpture is declining, the progress of science has had nothing to do with producing this condition. On the other hand, ancient sculpture lived by science. The ancient artists were more learned in the technics of their art than modern artists. In the renascence, Leonardo da Vinci and Michael Angelo were great scientific geniuses. Instead of killing sculpture, it is modern science which will finally be capable of rejuvenating it. Nothing, for example, has been of more value to art than the investigations of such men as Darwin upon the expression of the emotions. Ruskin has written that the sculptor can not be allowed to lack the knowledge or neglect the expression of anatomical detail; but that which is the end to the anatomist is for the sculptor the means. Detail is to him not simply a matter of curiosity or a subject of investigation, but the final element of expression and grace. The change of manners has not produced and will not produce the disappearance of statuary. We may not have another Venus of Milo or Hermes of Praxiteles. But no one can assert that the sculptor may not become capable of embodying in stone ideas and poetic emotions which the Greeks, with all the plastic perfection they attained, could not translate or even conceive. Praxiteles could not have imagined Michael Angelo's "Night" or "Aurora," any more than Michael Angelo could have executed some of the works of Praxiteles.

Painting enjoys a still greater promise of vitality and advancement. Color is eternal. No Newton, with his explanations of the aërial arch of the rainbow, will be able to break it up or to do away with it. The sense of color has even grown since antiquity. The Greeks were without words to describe a considerable number of colors which we distinguish; and their artists had certainly not as fine perceptions of color as Titian or Delacroix. Mankind seems to have been all the time growing more sensible to the language of tints, and to all the plays of light. Here, certainly, is an open road for art.

The language of sounds is likewise inexhaustible. The idea of melody responds to a particular mental and moral condition of man which changes from age to age; it will, therefore, change and make new advances with man himself. A class of musicians like Chopin, Schumann, and Berlioz have expressed feelings congenial to our epoch, and corresponding with a condition of the nervous system which Handel, Bach, and Haydn could hardly have understood. Mr. Spencer has shown that music is a development of accent made by the voice under the influence of passion. The variations of tone, the modulations natural to the human voice, grow refined as the nervous organization becomes more delicate. Musical melody following the variations of human accents is capable of taking on as many shades as there are feelings in the heart. Rossini has already been criticised with severity for the innovations he introduced into musical composition, and for his departure from the simple themes and solos of the olden time. A similar reproach was laid against Wagner, and is doubtless held in reserve for the next musical genius that shall arise.

Extinction has also been predicted for the poetic art, but with no better reason than for the other arts. Great poets still exist, and are still produced. They may not excel in the same way as their predecessors, but they excel as well, and reflect with equal power and equal grace the feelings of their age.

From the external conditions of art we pass to the mental and moral conditions; they are the most important ones. The question before us is, if the scientific spirit, which is gradually penetrating humanity and fashioning its brain from generation to generation, will not, in the long run, destroy the three essential faculties of the artist—imagination, the creative instinct, and sentiment.

According to some philosophers, the development of the scientific spirit is destined to arrest that of the poetic imagination. The reign of science, succeeding to the dynasty of legends and religions, will engender a reign of "platitude"; without mystery, say others—without superstition, Goethe added, there can be no true poetry. The poetic imagination does, in fact, need a kind of superstition, in the ancient sense of the word, which will not permit it always to explain events by their cold reasons, and a sort of ignorance, a demi-obscurity, under the cover of which it may play at will around things. Nothing is less poetic, we might say, than a broad, bare road devoid of nooks and turnings, with the sun shining directly upon it; but thickets, shrubberies, shady corners, or anything we can not look into at the first glance, whatever appears to hide from and evade us, these constitute rural poetry. The fault of bare plains is that they conceal nothing from us, and we do not like a straight line because we can see all there is to the end of it. The indefinable charm of evening consists in its showing us everything half veiled; and of moonlight that it gives a softness to objects whose outlines we can only dimly make out, and causes them to appear as through a thin, transparent obscurity. If the skies were cleared of what about them is mysterious, what would distinguish them from the earth we tread under our feet? The "aching for the infinite" that troubles some minds, also gives them some of their most precious joys; and such minds would probably be reluctant to exchange it for universal knowledge.

To us the incompatibility which these writers endeavor to establish between poetry and science is superficial. Poetry will always find a justification in science. Matthew Arnold remarks, in his essay on Maurice de Guérin, that poetry as well as science is an interpretation of the world. The interpretations of science will never give us that intimate sense of things that the interpretations of poetry give us, for they address themselves to a limited faculty, not to the whole man; for that reason poetry is eternal. All the theorems of astronomy will never prevent the view of the infinite sky exciting the vague restlessness in us and the unsatisfied desire to know which constitute the poetry of the heavens. Are there any discoveries that do not touch upon other mysteries, and thus favor the always still wider play of the imagination? Science, which begins by astonishment, ends also, Coleridge says, with astonishment, of which poetry as well as philosophy is born; there is, therefore, an eternal suggestion, and consequently an eternal poetry in science. That very craving for the mysterious and the unknown which the human imagination feels, will appear, if we analyze it to the end, a disguised form of the desire to know. We have just spoken of the peculiar charm of narrow roads, of thickets, and turnings; the chief source of their charm is in their allowing us to make discoveries at every step, in their keeping the mind in a constant stretch of curiosity. The poetry in them does not come only from their closing the horizon to us, but rather from their always promising us something new. That science is constantly changing the points of view from which we have been in the habit of regarding men and things, that it keeps on producing new light-effects, and often surprises, and even vexes us, no one will deny; but what is there in that to disturb the poet? I have sometimes envied the ant, whose horizon is so narrow that it has to mount a leaf or a stone to see a half step around itself; it must be able to distinguish a host of things that wholly escape us; to it a gravel-walk, a piece of turf, the bark of a tree, are replete with poetries unknown to us. If its view were enlarged it would be at first unhomed, and in the sight of our forests and mountains would miss the fleeting shadows of its grass-blades. So if we were to rise high enough we should regret to see the poetry of details disappearing, the little things blending together, all the angles in which our thought was lost smoothed away, all the turns that excited our curiosity straightened out. Nothing, at first sight, but the view of a grand whole, bare and shadeless, in a harsh, uniform light; but what breadth! As we survey it, we see still beyond it, a new set of endless perspectives still losing themselves in the shadows; still something to look at, to learn, and to experiment upon.

There is another mystery which science can not destroy, and which is destined to be always a theme of poetry; the metaphysical mystery. There is no need of weaving, as the theologians do, new obscurities around the one that everlastingly envelops the beginning of things; having got to that, the investigator himself, obliged to stop, may suffer himself, as Claude Bernard says, "to be rocked in the wind of the unknown, amid the sublimities of ignorance." Science may dispel, without poetry suffering by it, the artificial mysteries of religions, which apply their symbols even to the explanation of purely scientific phenomena; but it can never destroy this metaphysical mystery, which bears not only upon unknown laws, but upon the essence of things which are perhaps really incognoscible. That mystery will always be competent to sustain in art, above that of the beautiful, pure, and simple, the emotion of the sublime.

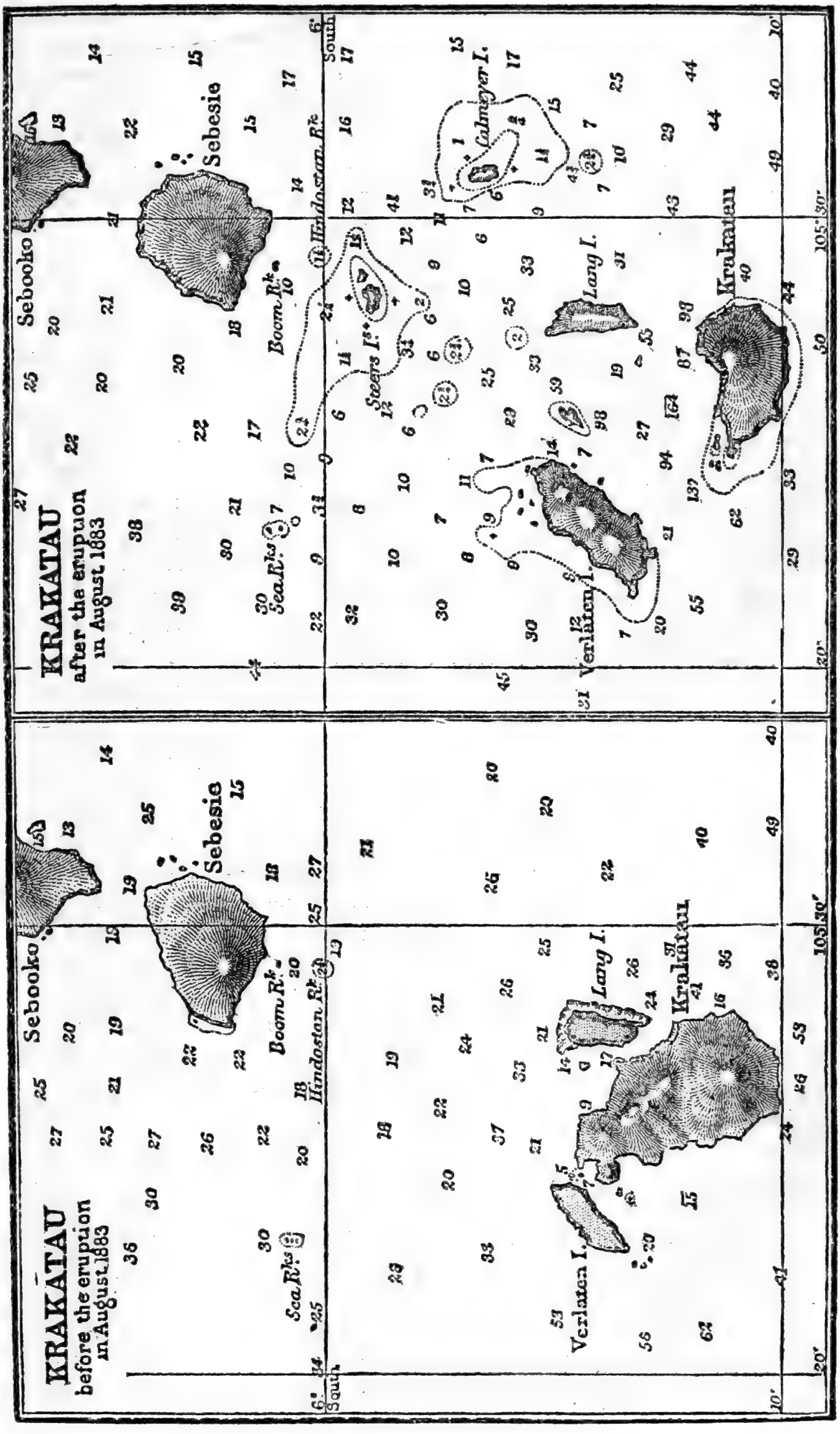
Superstition does not appear to us any more indispensable than mystery or ignorance to the flight of the imagination, although Goethe has described it as "the poetry of life." In their origin, it is true, the religious myths had their poetry; but it was, after all, because they were first attempts at explanation. Superstition consists essentially in putting in things, or back of them, wills like ours. Animals are not superstitious, because they do not try to comprehend. Man, on the contrary, tries to account for the phenomena he perceives, and, in order to do this, projects himself, in a fashion, into them. This first attempt to systematize the universe had a kind of grandeur, even in a scientific view, and had also its poetry. But the myths of the ancient ages can no longer be seriously regarded in the age of science. Is this to be regretted for the sake of art? Yes, they say; for it was more poetical to put wills like ours behind exterior objects than to submit them to the hard laws of science: a law is not as good as a god. But we answer to this, that a law in itself has something of the divine. As one of the characteristics of divinity is infinity, a law connecting phenomena one with another, and inviting us unhaltingly to ascend the chain of causes, opens immense perspectives to the mind, and gives to whoever investigates it a view of infinity in the smallest objects, or, we might say, makes the infinite present in every phenomenon. While mythology compels the mind to stop in its search for causes, giving the capricious will of some god as its final explanation, science removes all limitations and puts the mind in immediate view of infinity. From this arises a new kind of poetry, more austere, perhaps, but more profound and more lasting. When Leibnitz respectfully put back upon a leaf the insect he had taken from it to look at through the microscope, he did not regard it with the same eye as an ancient would have regarded it. In that atom he perceived, as Pascal did in the flesh-worm, an epitome of the world. This idea of the infinite divine is quite as precious as are the classic wonders and the tinsel decorations of Olympus. The poet loses nothing in the transformation of the universe by science. Mr. Spencer, who once defended the poetry of science against that of the Greek odes, has made some just remarks on this subject. To the man of antiquity or to the ignoramus of our own days, a drop of water is only a drop of water. How it is changed in the eyes of the scientific man when he thinks that, if the force that holds its elements together were set free, it would produce lightning! A dish of snow becomes a wonder when one examines with the microscope the varied and elegant forms of its crystals. A rounded stone striated with parallel scratches calls up the thought of the glacier silently sliding over it millions of years ago. Art and science have this in common, that both require genius as a condition of their full development. Science in its highest departments, like art, can not live and grow except by incessant discovery. The faculty which enabled Newton to divine the law of the stars is the same with that by which Shakespeare perceived the psychological laws that govern the characters of *Hamlet* and *Othello.* Like the poet, the man of science also must always be able to put himself in thought in the place of Nature, to learn how she acts, and to represent to himself what she might do if one should change the conditions of her action. The art of either is to place the beings of Nature in new circumstances, as if they were active personages, and thus, to as great an extent as possible, to renovate or new-create Nature. The hypothesis is a kind of sublime romance, a scientific poem. Kepler, Pascal, and Newton had, as Mr. Tyndall remarks, the temperaments of poets, almost of visionaries. Faraday compared his intuitions of scientific truth to "interior illuminations," to a sort of ecstasies that raised him above himself. Once, after long reflections on force and matter, he perceived in a poetic vision the whole world "traversed by lines of forces," the endless vibrations of which produced light and heat throughout immensity. This instinctive vision was the origin of his theory of the identity of force and matter. Science, then, in the face of the unknown, comports itself in many respects as poetry does, and demands the same creative instinct. For its advancement is required the power of intuitive intelligence collected by many generations; insight, as Carlyle calls it, to perceive the true or the beautiful before having a full knowledge of it.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE VOLCANIC ERUPTION OF KRAKATAU.

CONSIDERING that the volcanic eruption, of which the Straits of Sunda have been for the last eight months the center, is among the most stupendous of our times, and that the attendant phenomena have given rise to many questions of the highest scientific and, we may add, geographical interest, a *résumé* of the facts compiled from all the latest available sources may be interesting to our readers.

The Island of Krakatau (such, and not Krakatoa, is the native name) is situated in latitude 6° 7′ south, longitude 105° 26′ east, in the fairway of the Sunda Straits, about equally distant from Java and Sumatra, close on twenty-six miles west-southwest from the village and lighthouse of Anjer, the call-port or signal-station, prior to the present eruption, for all vessels passing through that frequented channel. It was a small, uninhabited island about five miles in length and three in breadth, culminating in two elevations, the taller of which, known as the Peak of Krakatau, rises (or did rise) some 2,750 feet above the sea. Surrounding it on all sides are numerous volcanic cones. The Tengamoes (or Kaiser's Peak) to its northwest is situated at the head of the Semangka Bay, and the quiescent Rajabasa to its northeast in the southern promontory of Sumatra; in the east by south the Karang smolders in Bantam, and southeast rise the active cones of the Buitenzorg Mountains. Standing in the straits and very little to the north of Krakatau are the two dormant or dead cones of Sebesie and Sebooko. A line drawn from Rajabasa, passing along the western side of Krakatau, and continued thence to Prince's Island, which lies off Java Head, would mark the boundary on the eastward side of the shallow Java Sea, which rarely exceeds fifty fathoms, and on the west side of the deep Indian Ocean. On looking at the accompanying map of the locality before the eruption it will be seen that close to the east and northwest sides of Krakatau there are two small fragments of land, Lang and Verlatin Islands respectively. It is Mr. Norman Lockyer's opinion that these are two higher edges of the old rim of a subsided crater, overflowed in part by the sea through inequalities in the margin between them; that the heights on Krakatau itself, the remaining portion of the old volcano summit, are cones elevated on this old crater-floor; and that the ancient funnel is practically coextensive with the area inclosed by these three islets, though till the 20th of May last blocked up by volcanic *dèbris*.

The earliest accounts of Krakatau we have been able to obtain are contained in a curious old volume, "Aenmerckelijke Reysen van Elias Hesse nae en in Oost-Indien van't jaar 1680 tot 1684" ("Remarkable Journeys of Elias Hesse to the East Indies from the Year 1680 to 1684"), published in Utrecht in 1694. The author relates that he passed on the 19th of November, 1681, "the Island of Cracatouw, which is uninhabited. It had about a year before broken out in eruption. It can be seen far at sea, when one is still many miles distant from it, on account of the continually ascending smoke of the fire; we were with our ship very close under the shore; we could perfectly well and accurately see the wholly burned trees on the top of the mountain, but not the fire itself." About the same period Johann Wilhelm Vogel, one of the Dutch East India Company's servants, who published in 1716 a very interesting account of his travels there, passed through the straits. He says: "On February 1, 1681, by God's help, in front of the Straits of Sunda, where, with great astonishment, I saw that the island of Cracketouw, which on my former journey to Sumatra appeared so very green and gay with trees, lay now altogether burned up and waste before our eyes, and spued out fire from great fire-holes. And on inquiry at the ship, Captain . . ., at what time it broke out, . . . I was told that it was in May, 1680. . . . The former year, and when he was on his voyage from Bengal, he had met with a


KRAKATAU
after the eruption
in August 1883
Sebooko
Sebesie
Boom Rk.
Hindostan Rk.
Sea Rks.
Steers Is.
Calmeyer I.
Lang I.
Verlaten I.
Krakatau
KRAKATAU
before the eruption
in August 1883
Sebooko
Sebesie
Boom Rk.
Hindostan Rk.
Sea Rks.
Lang I.
Verlaten I.
Krakatau
6° South
105° 30'

great storm, and about ten miles from this island he encountered an earthquake on the sea, followed by most frightful thunders and cracklings, from which he imagined that an island, or else a piece of the land, had burst up, and shortly thereafter, as they drew a little closer with the ship to the land, and were come near to the mouth of the Sunda Straits, it was evident that the Island of Cracketouw had burst out; and his conjecture was correct, for he and all the ship's company perceived the strong sulphur-atmosphere, also the sea covered with pumice, . . . which they scooped up as curiosities." Save for the observations of passing travelers, by whom the great beauty of its tree-clad slopes, the first verdant spot to meet the eye after weary weeks at sea, has been gratefully described, the volcano, after it died out, has had an uneventful and unrecorded history.

On the 20th of May last year, at half-past ten in the forenoon, the inhabitants of Batavia were astounded by hearing a dull, booming noise, whether proceeding from the air or from below was doubtful, soon followed by the forcible drumming and rattling of all the doors and windows in the place. The commotion was strongest between half-past ten and one o'clock in the day, and between seven and eight in the evening. About midday a curious circumstance was observed—that in some spots in the city no vibrations were perceived, although the surrounding buildings were experiencing them. It was at once concluded that a volcanic eruption of an alarming character had taken place, but for some time it was impossible to localize the direction of the sounds, though the west was the quarter of the compass to which most people assigned them.

A report, issued next day by the director of the observatory in Batavia, stated that, as he had no instruments for recording the intensity and direction of earthquake-shocks, he could certify only that no increase of earth magnetism accompanied the tremblings—the photographs indicating nothing abnormal; and that the quivering was absolutely vertical throughout the periods mentioned above; for a suspended magnet with an exact registering apparatus gave no indications of the slightest horizontal oscillations, but alone of vertical vibrations. This was verified by the observations of one of the philosophical-instrument makers in the town on a pendulum in his shop, where only vertical trillings were observable at a time when the windows and glass doors of the house were rattling, just as if shaken by the hand, in so violent a way that it was difficult to carry on conversation. Nowhere, however, do there seem to have been observed any shocks of a true or undulatory earthquake. From midnight of the 20th throughout the forenoon of the 21st the tremulations continued very distinct. The same morning a thin sprinkling of ashes fell, "whence, is not known," both at Telok-betong and at Semangka, situated in Sumatra at the head of the Lampong and Semangka Bays respectively. At Buitenzorg, thirty miles south of Batavia, the same phenomena were observed; while in the mountains farther to the southwest they were even more pronounced, and the Karang, a mountain situated about west from Batavia, it was thought must be the seat of disturbance. By this time the general opinion had decidedly ascribed to the west or northwest the direction whence the movements were proceeding. Krakatau itself was even named; but some of the Sumatran mountains were considered more likely to be the delinquents. Batavia being connected with that island by a telegraph line passing along the north coast of Java to Anjer, across the Straits of Sunda to Telokbetong, thence northward to Palembang on the east, and to Padang on the west coast, intelligence from all parts soon began to come in; but none of any eruption anywhere, beyond the notice of the fall of ashes mentioned above. Anjer telegraphed, "Nothing of the nature of an earthquake known or felt here." This was dated the 21st; a message in much the same terms had been received on the previous day, as well as the report of one of the Government officials to the following effect: "On Sunday morning, the 20th, I landed at Anjer, and there staid till one o'clock in the afternoon; at half-past three I reached Serang, and halted an hour. Neither I nor my coachman, either at Anjer or at Serang, or on my whole journey to Tangerang (near Batavia), felt or heard any earthquake or disturbance, or anything at all remarkable."

Anjer lies on the narrowest part of the Sunda Strait, twenty-seven miles from Krakatau, which formed a prominent object in one's seaward view from the veranda of its quiet little hotel on the sea-margin. This hotel was kept by one of Lloyd's agents, Mr. Schuit (whose family perished in the subsequent disaster), who had in his veranda a powerful telescope for reading the signals of ships for report to Batavia, and by whom consequently any occurrence in the strait could scarcely fail to be observed. Thus during the period of greatest disturbance in Batavia and Buitenzorg, when men there were referring the origin to Krakatau, eighty miles away, at Anjer, only twenty-seven miles distant from it, nothing was felt or heard. The same report was made from Merak, likewise situated on the straits, thirty-five miles from and presenting a clear outlook to the volcano. The winds prevalent in this region during the month of May are from the east, and would tend to drive any smoke and ashes toward the Indian Ocean, which might explain their not being detected from Anjer; but the direction of the wind fails to account for the entire absence in that and the surrounding villages of the phenomena which were most conspicuous in Batavia.

Not till the evening of the 21st was smoke observed to be issuing from Krakatau; on the 22d the volcanic vent there seems to have been fully established, and the vibrations and other phenomena experienced in Batavia quickly subsided. Now, in a letter to "Nature," Mr. H. O. Forbes has recorded the passage, during the 11th and 12th of July, of the ship (on board which he was returning to England) through extensive fields of pumice spread over the ocean north and south as far as the eye could reach. The vessel passed the volcano on the 9th, but till the evening of the 10th, when the steamer would be about a degree to the west (a little northerly) of her noon position, which was 102° 25′ east longitude, 6° 20′ south latitude, no pumice was observed. During the whole of the 11th the vessel was surrounded by the pumice-sheet, which about noon of the 12th, in 93° 54′ east longitude, 5° 53′ south latitude, suddenly terminated, shortly after it had appeared in greatest amount, while a current had been encountered after leaving the entrance to the straits, running against the ship's course at the rate of a quarter of a mile an hour. The pumice-nodules were considerably worn, but many pieces were observed as large as a child's head. Several lumps were picked up infested with barnacles, of from one to one and a half inch in length, which represented at least some four or five weeks' growth.

The specimens of pumice obtained at sea have been submitted to Professor Judd and the committee appointed by the Royal Society for the examination of the phenomena connected with the eruption. If, on analysis, they should prove different in composition from specimens obtained directly from the volcano, a different origin will have been established for them; but, should both turn out to have identically the same components, it will not necessarily prove that both have come from the same crater. The Peninsular and Oriental Company's steamer Siam, on her voyage from King George's Sound to Colombo, sailed for four hours, on August 1st, through a similar "lava" (pumice) sheet, in latitude 6° south, and 89° east longitude, the nearest land, the coast of Sumatra, being seven hundred miles off, and the current then running eastward at from fifteen to thirty miles a day. The soundings at the spot reached two thousand fathoms. Mr. Forbes, who incidentally referred to the eruption when reading his paper before the society on the 28th of January last, suggested that the sounds heard in Batavia on the 20th of May, which were altogether unperceived at spots so near Krakatau as Anjer, Merak, and Telok-betong, which would be inexplicable if they really originated there, were the result of a submarine eruption in the Indian Ocean, somewhere southwesterly from Java Head; and that the tremors were propagated thither perhaps by continuous strata connecting the *locale* of the outburst with Batavia, Buitenzorg, and more especially with the hills to the southwest, where the manifestations were so distinctly perceived. We know from Mr. Darwin's * and Mr. Forbes's † observations, that the center of volcanic disturbance does exist in that direction, in the Keeling Atoll, situated six hundred miles west by south from the mouth of the straits. Whether or not anything unusual has been experienced in these

* "Narrative of Survey Voyages of the Adventure and Beagle," vol. iii.

† "Proceedings of the Royal Geographical Society," December, 1879.

islands about the third week of May, no intelligence has yet reached this country. We know, from what occurred at Graham's Island, that pumice ejected from the sea-bottom rises to the surface, and an examination of the chart of the currents in the Indian Ocean at once shows that any flotsam in the region between west and south of Java Head in that longitude could be drifted to the locality in which it was observed in the month of July. If such a submarine outburst did take place, Mr. Forbes suggested that somehow the orifice very soon became blocked after a great in-rush of water had taken place, which, becoming transformed into steam under enormous pressure, shaped its course for the nearest old earth-scar, and found vent in Krakatau, by an offshoot probably of the funnel of the eruption of 1680. That such large lumps of pumice should be carried seven hundred miles westward into the Indian Ocean does not seem probable, and is not supported by any observations. The earlier outbursts were not of very unwonted vigor, for no pieces of any size are reported to have fallen on the neighboring coasts of Java and Sumatra; even after those of August, no ship farther off than one hundred miles speaks of the fall of any but the "finest dust and sand."

On the 23d of May, a ship encountered at Flat Cape, in Sumatra, a large amount of pumice on the sea, which increased in amount as Krakatau was neared. Of the appearance of the volcano on the 27th, we have a graphic account in the "Algemeen Dagblad" newspaper, of Batavia, by one of a party that ascended to the crater on that day. As they approached the scene, the neighboring islands had the appearance of being covered with snow. The crater was seen to be situated not on the peak, but in a hollow of the ground, which lay from southeast to northwest, sloping toward the north point, in front and to the north side of the lower summit, looking toward Verlaten Island. Both heights were seen; the southerly green, and the more northerly and much lower one quite covered with dust and ashes. The volcano was ejecting, with a great noise, masses of pumice, molten stone, and volumes of steam and smoke, part of which was being carried away westward by the monsoon wind, dropping all round and close at hand its larger pieces, while a higher rising cloud is specially recorded as driving away eastward, having evidently encountered a current in that direction in the upper air. Some of this dust-cloud was carried far to the eastward, for Mr. Forbes relates that on the morning of the 24th of May, when in the Island of Timor, twelve hundred miles distant, he observed on the veranda of his hut, situated high in the hills behind Dilly, a sprinkling of small particles of a grayish cinder, to which his attention was more particularly drawn later on that and the next day by their repeated falling with a sudden pat on the page before him. The visitors to the crater seemed to have viewed with most amazement the grandeur of the smoke-column whirling upward with a terrific roar like a gigantic whirlwind, through whose sides the ascending *ejecta*, vainly trying to break, were constantly sucked back and borne upward round and round in the center of its Stygian coils. The trees which once clothed this portion of the island presented only bare stems from which their crowns had disappeared, evidently not by fire, for there was no charring visible on them, but rather as if wrenched off by a whirlwind—perhaps of the crater itself.

After the 28th, curiosity in these volcanic phenomena seems to have abated, and during the next eight or nine weeks, though the eruption continued with great vigor, little is recorded of its progress; indeed, so completely did it seem to have been forgotten, that visitors to Batavia, unless they had made inquiries, might have failed to hear of its existence at all. During this period no local disturbances to attract attention or to cause the least alarm are recorded. From the logs of ships in the neighborhood of the straits, about the middle of August, numerous extracts have been published; but many of them show that they have been written either with the mind bewildered and confused by the terrifying incidents amid which the officers found themselves, or from the after-recollection of the events, of which under such conditions the important dry facts of time, place, and succession, are liable to be unconsciously misstated. Much is therefore lost which might have been known; but a few are of the utmost value.

On the 21st of August the volcano appears to have been in increased activity; for the ship Bay of Naples reports being unable to venture into the straits on account of the great fall of pumice and ashes.

The first, however, of the more disastrous effects were experienced on the evening of the 26th, commencing about four o'clock in the afternoon. They were inaugurated by violent explosions heard in Anjer, Telok-betong, and as far as Batavia, accompanied by high waves, which after first retreating rolled upon both sides of the straits, causing much damage to the villages there, and were followed by a night of unusually pitchy darkness. These horrors continued all night with increasing violence, till midnight, when they were augmented by electrical phenomena on a terrifying scale, which enveloped not only the ships in the vicinity but embraced those at a distance of even ten to a dozen miles. As the lurid gleams that played on the gigantic column of smoke and ashes were seen in Batavia, eighty miles off in a straight line, we can form some idea of the great height to which the *débris*, some of which fell as fine ashes in Cheribon, five hundred miles to the east, was being ejected during the night.

Between five and seven o'clock (for the hour is uncertain) in the morning of the 27th, there was a still more gigantic explosion, heard in the Andaman Islands and in India, which produced along both shores of the strait an immense tidal movement, first of recession and then of unwonted rise, occasioning that calamitous loss of life of which we have all heard.

The material thrown out rose to an elevation which we have no means of estimating, but so tremendous was it that on spreading itself out it covered the whole western end of Java and the south of Sumatra for hundreds of square miles with a pall of impenetrable darkness. During this period abnormal atmospheric and magnetic displays were observed ; compass-needles rotated violently, and the barometer rose and fell many tenths of an inch in a minute. Following at no great interval, and somewhere between ten and twelve o'clock in the forenoon of the same day, either by successive rapid outbursts or by one single supreme convulsion, the subterranean powers burst their prison-walls with a detonation so terrific as to have been, as it seems, inaudible from its very immensity to human ears in its close vicinity, but which spread consternation and alarm among the dwellers within a circle whose diameter lay across nearly three thousand miles, or fifty degrees of longitude.

With sunrise on the 28th the dense curtain which had enveloped so wide an area in darkness gradually began to clear off, and the light broke on a scene of devastation of the saddest kind, but on one of comparative placidity, as if Nature lay exhausted after her frantic paroxysm. Krakatau was seen reduced to a fraction of its original size ; the whole of the northern portion, with the height in front of which the volcano first broke out, and half of the peak itself, had vanished (see the accompanying map). To the northward, however, two new pieces of land, which have received the names of Steers and Calmeyer Islands, raised their tops above the surface of the sea, where the morning previous thirty to forty fathoms of water had existed. Of the two islets on each side of Krakatau, Lang Island is left practically unaltered, while Verlaten Island seems elevated somewhat, and is reported to be in eruption. But, where the volcano had been so active a few hours before, a sea fathomless with a line of a thousand feet is now to be found.

Having thus followed the succession of events, there remains little doubt that the crater on the 26th of August by its constant action had either cleared out the old funnel into its submerged portion, or that a rent by subsidence or otherwise was formed, through which a volume of water was admitted to the heated interior, resulting in explosion after explosion in increasing violence, as more material for generating steam was finding its way into the underground recesses.

The first great waves on the evening of the 26th and the early part of the 27th were probably caused by a portion of Krakatau being shot out northward for eight miles and dropped where we have now Steers Island ; while the appalling detonation in that forenoon and the greater wave accompanying it resulted perhaps from that still more Titanic effort which lifted the greater portion of Krakatau—several thousand million cubic yards of material—out by its one hundred and seventy fathom root, hurled it through the air over Lang

Island, and plunged it into the sea some seven miles to the northeast, where Calmeyer Island now blocks the channel which mariners have known so long as the East Passage.

The reports we have as to the tidal phenomena differ from different places. At many points it was observed that a distinct withdrawal of the water preceded the rise or great tide; while from others, as in the canal at Batavia, the opposite is given as the order of occurrence. Everything, however, depends on the moment of the observation. It will be apparent that these waves were the most natural consequents of the events, and were due certainly not to any seismic movement of the sea-bed, but, on the one hand, to the in-rush of water to fill the deep chasms out of which the ejected portions of the island came, which was naturally followed first by a withdrawal of the water, and then by a disastrous recoil over the low fore-shores of Java and Sumatra; and on the other hand to the tremendous stroke —the splash, in fact—imparted to the sea by such a gigantic block of matter, square miles in size, which must have resulted first in a great rise of water, followed by a withdrawal.

It is a remarkable circumstance that in the logs of several ships which were in the close vicinity of the volcano in the forenoon of the 27th, no mention is made of the great wave which proved so destructive, and which could scarcely, one conceives, have failed to attract attention. May the explanation not lie in the supposition that these two great waves—the in-rush and the splash waves—which would follow each other after a short interval, had neutralized each other at the spots where these vessels chanced to be at the moment? Issuing from the narrow straits into the oceans east and west, these waves started off on their journey round the globe, and, from the records of the tide-gauges which are now coming in, we have a most remarkable tale unfolded. On the afternoon of the same day that the greater of them swept away the Javan villages, the undulations were registered unmistakably in Mauritius, the Seychelles, in South Africa, and on the shores of the Pacific islands; but, as Mr. Lockyer informs us, they did not vanish there, but proceeded onward, and, crossing each other on the antipodes of Krakatau, journeyed back to the spot whence they had emanated, and this they did no fewer than four times before the equilibrium of the sea was restored so far as to be insensible to our instruments. While the tide-gauges have recorded their story, the delicate fingers of the barometrical registers of the world have also borne uninfluenced testimony of a similar kind. The blow which hurled such a mass of matter into the air, which originated a hurricane there and caused the barometers in the neighborhood of the volcano to rise and fall with unparalleled rapidity and a vessel distant three hundred miles to tremble, started an atmospheric wave also round the globe. It was first detected in the Kew registers, we believe, by General Strachey, who has now examined a large number of barographs, from which he has been able to fix the dates at which the atmospheric undulations passed various places on the earth's surface. As in the sea, so in the air, two waves, one to the east and one to the west, started from Krakatau, whose rate of progress has been found to be that of sound. One surprising circumstance, of which we have as yet observed no explanation, is how those ships which were near the volcano at the moment of the supreme explosions, of the enormity of which they seem not to have been cognizant, notwithstanding that they were heard at such immense distances, did not only not suffer from the concussion, but were not blown off the face of the water altogether. Almost coincident with the record of the abnormal atmospheric fluctuations, magnificent sunlight effects, unusually lurid skies, prolonged dawns, lengthened twilights, and green or blue or moon-like suns, began to be observed. From the dates at which these phenomena first appeared in different parts of the world—on the east coast of Africa on the second day, the Gold Coast on the third, Trinidad on the sixth day, at four thousand miles in the Pacific west of Panama on the seventh, and at Honolulu on the ninth day—it can be seen that the volcanic cloud followed a straight path.

To what height the supreme outburst propelled the smoke, dust, and the lighter portion of matter, it is impossible at present to estimate. Mr. Whymper saw Cotopaxi, in by no means one of its extraordinary expirations, eject a column over 20,000 feet in height; but many multiples of this distance will doubtless be required to measure the spire that was shot sky-ward on the forenoon of the 27th of August last. At all events it rose so high that months have been required for it to descend. Those places situated below the direct westward path of the cloud, which would be elevated at first as a narrow column, as they were carried under it by the eastward rotation of the earth, were the first to have the usual light of the sun changed into ominous displays or delightful after-glows, varying in intensity according to their time-distance away, and therefore to the amount of the obstructing dust, which would also condense moisture in the upper part of the air, and give special absorption effects,* that had by the hour they were reached subsided from the atmosphere. This narrow band, gradually spreading out north and south, enabled the inhabitants of all lands to obtain a view of the gorgeous effects of broken and absorbed sunbeams, and a demonstration of the vastness of the power of imprisoned steam.

Many questions connected with the subject remain at present unexplained; but the difficulties will in great part doubtless disappear before our fuller information. A committee of the Royal Society, consisting of our highest authorities in meteorological, volcanic, and light phenomena, has, as we have said, been appointed to fully investi-

* Cf. "Nature," February 21, 1884, pp. 381, 382.

gate the subject, and from their labors we shall by-and-by be in possession of the first really accurate and scientific examination of the effects of volcanic eruptions, which in this case bids likely to result, to meteorological science at least, in a gain whose immense importance it is impossible now to calculate. Nor is it unlikely that this "biggest terrestrial experiment" afforded us by Nature may ultimately prove to have been not the least of her beneficent gifts to humanity.—*Proceedings of the Royal Geographical Society.*

THE PREVENTION OF HYDROPHOBIA.*

By M. LOUIS PASTEUR.

THE important fact that certain viruses may be varied in potency, and that protection against one may be afforded by another less potent, is to-day not only gained for science, but has entered the stage of application. It is obvious that great interest attaches, in pursuing this line of study, to the investigation of methods of attenuation adapted to new virus. I announce to-day an advance thus made in regard to rabies.

In passing from a dog to a monkey, and then from one monkey to another, the potency of rabies-virus decreases at each transfer. After its strength has been thus diminished, if the virus is then transferred to a dog, a rabbit, or a Guinea-pig, it still remains attenuated. In other words, it does not regain all at once the intensity of virus from a mad dog. Only a small number of transfers from monkey to monkey is necessary to bring the virus to such a state of attenuation that it will not induce madness in a dog when introduced hypodermically. Even inoculation by trepanning, that most certain method of communicating rabies, will produce no result except that of causing in the animal a condition of insusceptibility to rabies.

The potency of rabies-virus increases in passing from one rabbit to another, or from one Guinea-pig to another. When it has been brought to a maximum in rabbits, it exhibits its full strength on being transferred to the dog, and is then more potent than virus from a mad dog. Such virus inoculated into the circulatory system of a dog invariably causes madness which results in death.

Although the virus rises in potency at each transfer from rabbit to rabbit, or from Guinea-pig to Guinea-pig, it must pass through several of these animals in order to regain its maximum potency, when this has first been reduced in monkeys. In like manner, the virus of

* Communicated to the Academy of Sciences, May 19, 1884, by M. Pasteur and MM. Chamberland and Roux.

a mad dog, which, as I have just stated, lacks much of being of maximum potency, when transferred to the rabbit, must pass through the systems of several individuals before reaching its maximum.

A rational application of the results which I have just made known leads readily to the rendering of dogs insusceptible to rabies. We have learned that the experimenter may have at his disposal attenuated rabies-viruses of different strengths; some which are not fatal will protect the system from the effects of more active viruses, and the latter against those which are fatal. Let us take an example. Rabies-virus is obtained from a rabbit which has died from trepanning after a period of incubation which exceeds by several days the shortest time in which the disease may be induced in the rabbit. This invariably takes place within seven or eight days after inoculation by trepanning with the most potent virus. The virus from the rabbit in which the incubation has been long, is inoculated, by trepanning, into a second rabbit, and the virus from this one into a third. With each successive transfer, some of the virus, which becomes stronger and stronger each time, is inoculated into a dog, who becomes gradually more hardened against the operation of the poison, until he is finally found capable of withstanding a fatal virus. He then becomes entirely insusceptible to rabies, the virus of a mad dog producing no effect upon him, whether introduced by intra-venous inoculation or by trepanning. By inoculation of the blood of rabid animals, under certain conditions, I have succeeded in greatly simplifying the operations of vaccination, and in producing in the dog the most decided state of insusceptibility. I shall soon make known the details of the experiments on this point.

Until the time when rabies shall have become extinct through vaccination, the prevention of the development of this affection, in consequence of bites by rabid dogs, will be a problem of considerable interest. In this direction, the first attempts which I have made give me the greatest hopes of success. The period of incubation after biting is, I have every reason to believe, of such length that the subject may be rendered insusceptible before the fatal form of the disease develops. The preliminary experiments are very favorable to this opinion, but the tests must be infinitely multiplied on various species of animals before therapeutics will have the boldness to try this preventive on man.

Notwithstanding the confidence with which the numerous experiments I have made during the last four years inspire me, I do not announce the facts that point to a possible prevention of hydrophobia without some apprehension. Had I had sufficient material means, I should have preferred not making this communication till I had solicited, by the kindness of some of my associates of the Academy of Sciences and the Academy of Medicine, the verification of the conclusions I have just made known; and I have requested M. Faillières, Minister of Public Instruction, to appoint a commission to which I may submit the dogs I have rendered insusceptible to rabies.

The crucial experiment which I should try at the first opportunity would be to take from my kennels twenty dogs insusceptible to rabies, which should be put in comparison with twenty other dogs. The forty dogs should be caused to be bitten successively by rabid dogs. If the statements which I have made are correct, the twenty dogs deemed by me insusceptible will all escape, while the other twenty will be attacked by rabies. In a second experiment, not less decisive, forty dogs would be used, of which twenty had been previously vaccinated, and the others had not. The forty dogs should be trepanned with the virus of a mad dog. The twenty vaccinated dogs would escape, and the other twenty would all die of rabies, with paralysis, or with mania.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE MORALITY OF HAPPINESS.

BY THOMAS FOSTER.

CARE FOR SELF AS A DUTY.—(CONTINUED.)

IT will perhaps be sufficient, in response to numerous inquiries addressed to me respecting the supposed religious bearing of these papers, to remark that they are not intended to have any religious bearing whatsoever. I am simply inquiring what are the rules of conduct suggested when each person takes as his guiding principle the increase of the happiness of those around, an expression which must be taken as including himself in the same somewhat Hibernian sense in which Milton included Adam among "those since born, his sons." I may add that nearly all the letters addressed to me have been interesting, and some have been singularly well-reasoned—all utterly unlike the rather spiteful and very silly letters I referred to in a footnote to my last paper. Yet I can not suffer the religious element to be imported into the subject—no matter how courteously or kindly the thing may be done. I have just the same objection to see the question of the evolution of conduct considered from that side, which the student of astronomy or geology has against dealing with the objections and difficulties raised by those who seem always to suspect that under the teachings of God's work, the universe, there may lie some grievous deceptions if not some monstrous falsehoods. If my reasoning is bad, it can be met and overcome on its own ground.

I may, however, make this general remark with regard to all systems of morality whatsoever, including those which have come before men in company with religious teachings. Without a single exception every one of these systems includes—and professes to include—features suitable to the special time and the special place when and where it was propounded. How much of any system may thus be regarded as local or temporary or both may be a moot point; but that some of each system is of that sort is absolutely certain. "Because of the hardness" of men's hearts the Mosaic system, for instance, had certain rules; and, because of the weakness of their hearts (who can doubt it?), the system which replaced that of Moses had certain other rules. The same is true of every system of conduct ever propounded. We may believe the rule sound and good in its own time and place, "Whosoever shall smite you on the right cheek turn to him the other also," and "If any man will sue thee at the law and take away thy coat, let him have thy cloak also." A man may believe these rules to be more than sound and good, to be of divine origin—yet recognize that in our own time, and here, in Europe or America, the rules would work ill. He who so taught recognized in the same way that other rules which had been good in their time had lost their virtue with changing manners. He knew *where* it is written, "Thou shalt give life for life, eye for eye, tooth for tooth," and so on; yet he only quoted these Scripture teachings to correct them—"But *I* say unto you, that ye resist not evil, but whosoever," etc. When he thus corrected what was "said by them of old time," he did not show disrespect—whatever the Scribes and Pharisees tried to make out—for the teachers of old time, whose words he read and expounded. He knew that "old times were changed," and therefore old manners and morals gone. He said, "Suffer little children to come unto me," and loved them, *not* teaching—as had seemed more convenient and was (let us believe) better, in earlier days—that the child would be spoiled unless diligently belabored with the rod.

These times and the races and the nations now most prominent on the earth are even more unlike the community in Palestine nineteen centuries ago, than that community was unlike the Jewish people in the days of the more ancient lawgiver. The opponents of evolution may prefer to believe that the human race has been stereotyped; but facts are a little against them. And even if we admitted the imagined fixedness of the human race for nineteen centuries, they would still have to explain the contradiction between two systems for both of which they find the same authority. Of course, there is no real or at least no necessary contradiction. Grant the human race to be what we know it to be, a constantly developing family, and the contradiction vanishes—we simply learn that what is best for one time is not best for another, even among one and the same people; how much more, then, must the best rules of conduct vary when different peoples as well as different times are considered!

All this, however, is a disgression, which should have been unnecessary, but has in a sense been forced on me by the misapprehensions of many well-meaning critics (and a few who are not well-meaning at all, but of the Honeythunder order, teaching the law of love by reviling and worse).

The duty which each man owes to himself in regard to the maintenance of his health, the development of his powers, and so forth, which becomes a duty to others when regarded with reference to those more immediately around him or dependent upon him, and is still manifestly a duty in relation to others where the advancement of the general well-being, so far as he can influence it, is considered, has another aspect when considered in reference to those classes (D and E) * whose encouragement or increase would be injurious to the body social. It is not only essential to the evolution of conduct in the right direction that those who may be classed as "men of good will" † should increase relatively in number and influence, but also that those who are either absolutely men of ill-will, or are so far not of good-will that they disregard the well-being of others, should be checked and discouraged.

This requirement for the evolution of the more altruistic kind of conduct involves in many cases—as a duty—conduct of a kind which the few real members of Class A and the many members of Class C who speak of themselves as belonging to Class A—regard as self-assertive. It becomes a duty, when the matter is viewed in this light, to assert just rights and resist wrongful claims. For, every act of carelessness or self-neglect in such matters tends to the encouragement of the less valuable or noxious classes which profit by it. It may be that to uphold just claims or resist wrong-doing may be less comfortable than to give way. In such a case the duty becomes an altruistic one, however egoistic the action based on the consideration of such duty may appear. But in a number of cases the claim upheld may be well worth upholding in itself, the wrong resisted may involve gross injury. In such a case the care of a personal right or the resistance of a wrong is, in itself, egoistic. Yet may it well be that the person concerned may esteem it better to give up the claim or to yield to the wrong, until he recognizes that the idea of self-sacrifice, however beautiful in itself, may involve a far-reaching wrong to the better members of the body social.

We touch here on considerations which are in question every day, almost every hour, of our lives.

Consider home-life, for example. In nearly every home there are those who are disposed to take unfair advantage of the rest; and they are far better restrained by the quiet resistance of their attempts than in any other way—certainly far better than by yielding, continued till

* See "Popular Science Monthly" for May, p. 109.

† It may not be generally known outside the Roman Catholic community that the message rendered in the authorized version of the New Testament "Peace and good-will toward men," is otherwise rendered "Peace to men of good-will." The revised version reads "Peace among men in whom He is well pleased," which would in effect be nearer the Roman version.

nothing but the anger roused by some attempt, more barefaced than the rest, moves to resistance. We see this especially exemplified in the families of careless parents—unselfish perhaps in a sense, but really negligent of their duties. It has been said for this reason that unselfish parents have commonly selfish children, which seems contrary to the law of heredity, but illustrates rather the natural influence of defective training. The fact really is, that the children of selfish parents are as a rule more selfish in character than those of the unselfish; they grow up to be as unpleasant in their ways as the children of careless, unwatchful parents; and their unpleasantness is more apt to be permanent. Yet the unchecked ways of children whose parents yield unwisely to them, illustrate well on a small scale (even though happily the mischief is often transient) how the assertion of just claims, and the restraint of wrong-doing, involve a form of egoism which must be regarded as a duty.

In life outside the family, we constantly find the duty of resisting evil presenting itself in apparently egoistic aspect. In hundreds of ways the members of Class C show their readiness to become members of Class D and members of class D to develop their unpleasant ways. The adoption of considerate habits and care for the just claims of others in all the multitudinous details of our daily life, constantly lead to attempts by the selfish and obnoxious to take advantage of what they regard as mere weakness of disposition. In such cases, while it is by no means desirable to give up ways which are in themselves essential to the well-being of the society of which we form part, we must—as a duty—resist the encroachments of objectionable persons—not the less that the matter insisted upon is one to which we attach importance, so that our firmness has its egoistic aspect. Men are but children of a larger growth, and there is no surer or better way of eliminating at least the grosser forms of selfishness than by so resisting unjust claims that they—simply fail. This is the appropriate punishment—akin to that which Mr. Spencer regards (most justly in my opinion) as the only proper form of punishment for children, viz., punishment which is the direct consequence of ill conduct. Of course, it will happen that mere resistance of a wrong may bring definite punishment—directly or indirectly—to the wrong-doer; but (apart from such cases, in which we have to ask whether justice may not need to be tempered with mercy) all I would insist on is that the selfish, grasping, oppressive members of the body social should be so resisted that, whenever it is possible, they fail of their unfair purpose.

The rule applies in small matters as well as great. Mr. Spencer himself notes (though it is when dealing with selfishness specifically) a case of not infrequent occurrence, and perhaps of a trifling enough kind—the acted falsehood of railway-passengers who, by dispersed coats, make a traveler believe that all the seats in a compartment are taken when they are not. Here the detection and resistance of an attempted wrong, contemptible as it is, may excite some sense of shame in the wrong-doers, though conceivably not (for such wrong-doers are of a shameless sort); but the defeat of their purpose will at the least involve disappointment and serve as a discouragement from such attempts in the future. Of course, a very zealous opponent of the obnoxious section of society might not be content with what I here advocate as the simple line of duty in such cases. He might (as an earnest opponent of evil did—rather harshly I think—the other day) take on himself to punish as well as to resist evil; and having been met with the customary falsehood as to some article deposited in a vacant seat, might pitch it out of the window, with the remark that he would be responsible to the real owner when he appeared. But this is going beyond the strict line of duty in such matters.

It will appear manifest, I think, on careful consideration of the matter by any one who notes, for a few days or even hours, the course of events around him in his family and in society, that he who neglects to defend his own rights against the encroachments of Class D as well as of Class E, and of Class C as well as of Class D, fails as clearly in his duty to the social body as the parent who overlooks selfish and unruly conduct in his children. And just as the children themselves whose training is thus neglected have really just reason, did they but know what is good for them, to complain of such mistaken kindness, so even the more selfish (all but the members of Class E) have no less reason than the unselfish, did they but know their own interests, to desire that considerate but firm and self-regardful conduct should prevail throughout the body social.

It has been shown that care of self necessarily precedes care of others, because we must ourselves live if we are to benefit others. It has been shown further that if there is to be progress and improvement in the race, the superior must profit by their superiority, and so develop in numbers and influence, while the inferior because inferior become less and less predominant in the community. Further, it has appeared that while a society improves as it becomes constituted more and more largely of the better sort, this improvemeut depends in large part on those qualities of the individual members of society which depend on due care of self. In like manner it appears that in a society whose members are not duly regardful of self, misery arises from the excess of self-denial which ends by making those who practice it burdens on the rest of the community. Lastly, we have seen that due care of self is desirable, and neglect of the just rights of self injurious to the social body, because that undue care of self which is properly called selfishness, and leads either to negative or positive forms of wrong-doing, thrives and multiplies in a community where the better sort allow evil and oppression to pass unchecked by the due assertion of self-rights.

But now it is worth remarking that the line of reasoning which has been followed does not in reality indicate changed conduct. It reconciles the actual conduct of the better sorts of men with rules derived from observed facts and laws in regard to the development of conduct, and would tend to reconcile their conduct with their words, if men in general would but recognize the folly and danger of a system by which they have one set of rules on their lips and another for their actual guidance. As Mr. Herbert Spencer well puts it, the general conclusion to which we have been led, "though at variance with nominally accepted beliefs, is not at variance with actually accepted beliefs; while opposed to the doctrine which men are taught should be acted upon, it is in harmony with the doctrine which they do act upon and dimly see must be acted upon. . . . The laborer looking for wages in return for work done, no less than the merchant who sells goods at a profit, the doctor who expects fees for advice, or the priest who calls the scene of his ministrations a 'living,' assumes as beyond question the truth that selfishness, carried to the extent of enforcing his claims and enjoying the returns his efforts bring, is not only legitimate but essential. Even persons who avow a contrary conviction prove by their acts that it is inoperative. Those who repeat with emphasis the maxim, 'Love your neighbor as yourself,' do not render up what they possess so as to satisfy the desires of all as much as they satisfy their own desires. Nor do those whose extreme maxim is, 'Live for others,' differ appreciably from people around in their regards for personal welfare, or fail to appropriate their shares of life's pleasures. In short, that which is set forth above as the belief to which scientific ethics lead us, is that which men do really believe, as distinguished from that which they believe they believe—or pretend they believe."

Which is better?—to proclaim with our lips rules of conduct which none of us really follow, and to denounce those who show that the rules which the best-minded among us really strive to follow are such as tend most to improve the condition of the body social, or frankly to recognize the just and equitable rules of conduct which after all are the real guides of the actions of all well-meaning men? Is it well or wise to discredit these fair and proper rules by setting up others which seem more self-sacrificing, but which none except a few abnormally-minded persons of no influence (objects of ill-concealed contempt among those who applaud such rules) actually strive to follow—rules, moreover, which if widely followed would inevitably bring misery on the community? For my own part I believe that the system by which rules no sane man follows are set up as the real laws of conduct, works most serious mischief, by discouraging many from the attempt to be consistently fair and just to those around them as well as to themselves. Of what use, they feel (rather than consciously think), is any attempt to be merely just and considerate, when still we fall far short of the standard set up for our guidance? Apart from this lies the direct mischief to character which necessarily arises from the confident expression of acceptance of rules which every man (except the few abnormal creatures I have mentioned) knows well that he does not follow, has never attempted to follow, and never intends to follow. Many are led, through their honest unwillingness thus to falsify their words by their actions, into an error of the opposite kind; preferring rather to maintain rules of conduct which have a selfish aspect, while their actual conduct is unselfish, than to ape a degree of disinterestedness which they do not possess, and which would (they know) be mischievous if really possessed and acted upon by any large proportion of the community.*

But, lastly, let it be noticed that just care for self does not imply necessarily less care for others, but often more. As a mere matter of fact, men who carefully consider their own just claims are found to be more considerate, as a rule, of the claims of others, than those who assert that men ought not to be careful to consider what their just claims are. Horace long since, in his famous ode beginning "*Justum ac tenacem propositi virum*," drew attention to the connection commonly existing between justice and firm maintenance of what is due to self. Of course, there are men who are unduly regardful of self, not being content with the maintenance of their own rights, but willfully infringing the rights of others. Equally are there some who while negligent of their own rights are considerate of those of others. But these are the exceptions. As a rule one may recognize in *due* regard for self-rights the same principle which displays itself otherwise in care for the rights of others. Considering social as distinguished from individual opinions, assuredly Mr. Spencer is justified in what he says on the egoistic excesses which often accompany excessive altruism: "A society in which the most exalted principles of self-sacrifice for the benefit of neighbors are enunciated, may be a society in which unscrupulous sacrifice of alien fellow-creatures is not only tolerated but applauded. Along with professed anxiety to spread these exalted opinions among heathens, there may go the deliberate fastening of a quarrel upon them with a view to annexing their territory. Men who every Sunday have listened aprovingly to injunctions carrying the regard for other men to an impracticable extent, may yet hire themselves out to slay, at the word of command, any people in any part of the world, utterly indifferent to the right or wrong of the matter fought about. And as in these cases transcendent altruism in theory co-exists with brutal egoism in practice, so conversely a more qualified altruism may have for its concomitant a greatly moderated egoism.

* It is, by-the-way, rather remarkable that in proportion to the apparent zeal with which some maintain the doctrine of universal love is the intensity of hate which they express and doubtless feel (being in this at least, let us hope, honest) for those who differ from them. If the Honeythunder School of Philanthropists act seemingly on the principle, "Curse your souls and bodies come here and be blessed," these seem to adopt as their rule, "Let us hate with all our might those who will not allow us to love every one better than ourselves."

For, asserting the due claims of self is, by implication, drawing a limit beyond which the claims are undue; and is, by consequence, bringing into greater clearness the claims of others."

We have next to consider the duty of caring for others, as it presents itself in connection with the morality of happiness.—*Knowledge.*

DISEASES OF PLANTS.

By D. P. PENHALLOW,
LECTURER IN BOTANY, MC GILL UNIVERSITY, MONTREAL.

STUDIES in vegetable pathology are by no means a recent development of science. So long ago as 1795, Schreger * issued a work treating of the various diseases then known, the work being in reality a compilation of the literature of the subject, which, up to that time, had been very much scattered. Then came a rather wide gap, until in 1833 Unger issued his work entitled "Die Exantheme der Pflanzen und einige mit diesen verwandte Krankheiten der Gewächse." From that time until the present we find the well-known names of Meyen, De Bary, Sorauer, Hartig, Frank, and others linked with a tolerably copious literature on this subject. We find the Germans among the first, if not the very first, to recognize the desirability of pursuing questions of this kind from a scientific stand-point, though, aside from purely scientific considerations, these questions were forced upon the general attention of the country from an economical stand-point. It was recognized that the important interests involved in forest-growths were liable to be seriously impaired through the operation of disease, and that, even were this not the case, the interests involved could be most fully protected by the development of that knowledge which should secure the best oversight and care of forests in all respects. A wise policy, therefore, dictated the establishment of forestry stations, the duties of which included a study of the various diseases affecting trees.

In America hardly a serious thought has yet been given to such considerations, so far as they extend to the protection and preservation of our forests; but it seems probable that the movement to protect our forests from ruthless destruction at the hands of man, which is each year assuming more tangible shape, must ultimately embrace also an effort to have our trees studied according to strict scientific methods, for the purpose of determining their relation to disease and protecting them from injury. But, while we find the question unconsidered from the exact stand-point which first developed in Germany, we do find

* Erfahrungmässige Anweisung zur richtigen Kenntniss der Krankheiten der Wald- und Gastenbäume, etc., Leipsic, 1795.

that it has been forced upon our attention in another and, for those immediately interested, more unpleasant way.

For the last hundred years or more, under the influence of the peculiar methods of cultivation which have been employed by our fruit-growers, various diseases have appeared from time to time in several of our important fruits, and to such an extent have some of them developed within the last ten or fifteen years that they have completely destroyed the fruit industry in some sections, and now threaten a more general annihilation of one of the most enticing and profitable occupations for the farmer. For the last hundred years we have heard of the "blight" in pear-trees, and the best records show unmistakably that the disease has been on the increase during that period. So badly is it developed in some fruit sections, as through Southern New York, that it is a matter of extreme difficulty to find a really healthy tree. For the last eighty years we have also heard of the "yellows" in peaches, and here again we find that history records a constant development of the affliction. So serious have its ravages proved that whole sections have been deprived of the very important industry of peach-culture. Not only this, but the disease is now so thoroughly established, and has come to be so much a matter of inheritance, that the life of the tree is greatly modified and even determined by it. The peach is naturally a long-lived tree, instances brought to my notice showing that it may live for upward of one hundred or more years, and, if well cared for, it will certainly produce fruit for a long period. At the present time, however, as in the great peach districts of Delaware and New Jersey, we find that, owing to the certainty of disease appearing, or the inherently weak constitution resulting from its previous operation, the period of a profitable life is limited to nine years, at the end of which time the trees are rooted out of the soil as worthless.

Twenty-five years ago the Hudson River Antwerp came into cultivation in Southern New York, and for a long time was a famous berry, and made money for those who cultivated it. Within a few years a disease has appeared, and to-day it is considered worthless to the fruit-grower. And so it is with others of our important fruits. Diseases are yearly becoming a more and more familiar foe for the horticulturist to deal with, and a great deal of alarm is felt, and with reason, lest the fruit industry in some directions be completely destroyed. Thus it is that within a few years it has become imperative that something be done, looking to the acquisition of facts which will enable us to successfully cope with these disorders, to ward them off or arrest their progress. Fortunately, the question is an important one, and so is yearly claiming more careful attention from scientific men.

Diseases arise from such a variety of causes, and are so various in their effects, that we can not judge them all from the few given as illustrations. Moreover, there seems to be such an inadequate conception of the nature and extent of these disorders in plants, as well as of their influence, that it seems desirable to present a general outline of the subject according to our present knowledge. We will, therefore, pass over a special consideration of the various scientific investigations of the last few years, and deal with the conditions under which the diseases develop, as well as some of the most important results of their action. First, let us briefly consider what constitutes a disease.

In the animal the system is considered diseased when the functions of the body cease to be performed in a normal manner, and the disease is more or less serious, according to whether one or more functions are involved, as well as the degree to which the impairment of a particular function is carried. In instituting pathological comparisons between animals and plants, we have to keep in mind that there are important structural differences and physical peculiarities which may favor the development of disease more in one case than the other. In animals the mass of their structure is composed of highly vitalized and actively growing cells and tissues ; while in the higher plants, where the differentiation of structure is carried to a high degree, there is a very considerable portion of the body which has become incapable of further growth, and is virtually dead. In many cases, as in trees, the permanent structure predominates, and the vitalized tissues are relatively few. Furthermore, through a delicate nervous system which penetrates the most remote parts of the body, the whole animal organism is brought into more or less active sympathy with the diseased portion, even though the disorder be one of a strictly local nature, while the blood as a general medium of circulation tends to distribute the affection and thus bring the entire system into a diseased condition. In the vegetable kingdom we find no fluid which would be strictly equivalent to the blood of animals and capable of disseminating disease through the organism in a similar manner. Recent researches by Hillhouse,* however, seem to strongly confirm the previous observations of Gardiner, Strasburger, Frommann, and others, that there is a well-defined continuity of the protoplasmic substance between adjoining cells through their walls, thus rendering it highly probable that, in plants, the protoplasm may act in a manner similar to the nerves of animals to bring somewhat remote parts into more or less active sympathy, and this consideration must have weight in the future, as giving us a more correct insight into the operation of disease and the possibilities of its complication.

If we clearly recognize that the physical basis of life is the same in both plant and animal, and that it is through disturbance, primarily, of the protoplasmic functions that the functions of the organism as a whole are disordered, then from this and what has already been stated it becomes evident that the pathology of plants and animals is the

* Bot. Centralbl., XIV, 1883, pp. 89–94 ; Journal Royal Mic. Soc., Ser. II, vol., iii, p. 524.

same, chiefly involving greater degrees of complexity in the latter, and that we must apply the same principles for the recognition of disease in each case. This view was expressed so long ago as 1846,* and receives confirmation in the expressions of some of our best pathologists of the present day.† Frank ‡ tells us that "disease is every deviation from the normal condition of the species"; while Sorauer # says, "We must recognize as a disease every disturbance of the organism which detracts from the final end of its labor, the accomplishment of its purpose."

In considering the diseases of plants, it is important to bear in mind that we have to deal with subjects which on the one hand are cultivated, and on the other hand not. In forest-trees there has been no modification through cultivation, and disease would not be likely to become complicated from this cause. In cultivated trees, and plants, as in the peach, pear, strawberry, raspberry, etc., a high degree of cultivation has resulted in a corresponding modification upon which the pecuniary value directly depends. This strong divergence from the original type involves a debility in one or more directions, and is quite parallel with the changes known to occur in more highly civilized communities of men, by reason of which diseases are not only likely to be more prevalent but more complicated. This analogy, as well as general principles, would show us that the more highly cultivated the varieties of fruits or plants, the more susceptible are they to the influence of environment with the introduction of disease, and this is confirmed, not only by personal observation, but by the experience of practical fruit-growers.

Again, cultivated fruits always tend to revert to the original form when the conditions of their high state of development are withdrawn. Moreover, such organs often show that this excessive development has obliterated, wholly or in part, those important functions connected with the reproductive processes which they were originally designed to fulfill. These are some of the evidences that all such monstrosities as our modern apples, pears, strawberries—in short, all our cultivated fruits—are in reality abnormal growths which we may designate as hypertrophied structures, and are therefore evidences of disease. In such cases, therefore, the questions of treatment are likely to become somewhat complicated, since, while maintaining a certain form of disease, we must exclude, prevent, and cure all others.

Diseases may be general in the system, or they may be localized, and this is a consideration of obvious importance when we bear in mind that, according as they are one or the other, they may be more or less destructive in their effects or be controlled with greater or less difficulty. When a disease involves the entire system, as in peach-yellows or pear-blight, it is often a matter of great difficulty to deter-

* Smee on "The Potato Plant."

† "Lancet," 1880, vol. ii, pp. 605, 645.

‡ "Krankheiten der Pflanzen," p. 2.

"Handbuch," p. 56.

mine the controlling treatment; but in other cases, where the disorder is strictly of a local character, it may be a simple matter to remedy the trouble. In the case of those peculiar developments of the oak which give us the gall-nuts of commerce, or of similar abnormal developments in the tissues, we have instances of well-defined disease, but it is of a strictly local nature; the disturbance of functional activity does not extend beyond very narrow limits. It becomes, then, a simple matter to treat the case, because the part may be removed without inflicting injury upon other organs of the plant, and thus the knife is the sure remedy. Or, again, certain diseases may originate in the breaking of a limb or the fracture of a surface tissue. In such cases the disease will follow the injury and progress slowly, but it is often a simple and easy matter to prevent its introduction into the general system by properly caring for the wounded part in the first instance. Nature herself provides the means of warding off disease in just this way, and within certain limits her provisions are most effective. If a structure such as a vigorously-growing plant be injured, there at once appears a clear fluid, which gradually thickens into a mucilaginous substance, and finally becomes dry and hard. Under its early protection, a tissue of cork is formed over the wound as a healing and protective structure, impervious to air or water. Under it, the injured parts, now excluded from the air, are able to perfect the healing process by the formation of new tissue.

In plants, as in animals, diseases may be developed through a great variety of causes, but it is possible to bring them into a rude system of classification by means of which their consideration is greatly facilitated. The best arrangement of the kind which we have at present, one which answers very well, is that of Hartig,* according to which diseases are developed through the action of—

1. Phenogamic plants.
2. Cryptogamic plants.
3. Injuries.
4. Soil influences.
5. Atmospheric influences.

Under the first head we have to deal with those plants, like the mistletoe and dodder, which grow upon others and draw their nourishment directly from them—hence are truly parasitic. Plants of this kind may contain a certain amount of chlorophyl, but usually possess no true roots; hence they are not only incapable of drawing nourishment directly from the soil, but they are also incapable of performing the assimilative functions by which materials for the formation of cellular structure are developed, in more than a limited manner if at all. Such plants, therefore, must depend entirely upon the already elaborated sap contained in their hosts, and, feeding exclusively upon this, the latter must suffer in a degree which is proportional to the devel-

* "Lehrbuch der Baumkrankheiten," p. 6.

opment of the parasite. The tissues in which the latter feeds must thus become diseased, primarily through lack of nutrition, and so finally develop in an abnormal manner, as is seen to be the case in the often enormous knots which accompany the growth of the mistletoe upon the oak. Such excrescences often reach a diameter of three or more feet. A secondary feature of such diseases is then developed in the readiness with which such hypertrophies often yield to decay, or in the decay which is introduced into the various tissues of the host wherever the parasite penetrates. It is evident that diseases of this character may be, and usually are, of a strictly local nature, and, in the early stages at least, it is easy to remove both the disease and the cause by amputation. When local action has been long continued, however, the highly morbid condition of a limited portion of tissue may in time find sympathy in adjoining parts, and so by degrees the whole system become involved in a chronic disorder. We may thus remove the cause, but additional treatment will be essential to restore the system to its normal condition.

In the second class of causes we have the cryptogamic parasites, or, more properly, the saprophytes, to contend with. These plants, like the parasites proper, are incapable of providing their own nourishment from the soil and air, and so must depend for their growth upon already-formed organic matter. But this is not all: it is characteristic of their growth that they live upon organic matter which is in an active state of decomposition, and it will thus be easy to see that they are not far removed from being the cause of the decomposition in bodies which have already ceased to live. In their action upon non-vitalized matter, it is quite possible that they are the active promoters of disorganization; but the case is somewhat different with the living organism. Here the growth of the saprophyte has to contend with the vitality of the host, and, so long as this latter is normally maintained, it is most probable that the intruder will fail to gain sufficient hold to exert any appreciable injury. But the struggle continues, and if, by reason of accident or peculiar conditions of environment, the vitality of the host be reduced below certain limits, then the saprophyte or parasite, as the case may be, at once exerts a preponderating influence which is highly deleterious. Or, again, if the plant be diseased through the operation of other causes, then the fungus can exert its influence to produce secondary features of an already disordered condition. These views find confirmation in the general action of fungi upon tissues. It is observed that they are more or less abundant in the rough outer bark and on the surface of most plants; but, though they are present, their growth is limited, and confined to those tissues which are either dead or of very low vitality, while the plant suffers in no wise from their presence. Let the plant be injured or diseased, however, and at once the parasite gains a firmer hold, the tenacity of which will increase continually until remedial measures are applied. Thus, we often find the breakage of a limb to be but the open door by which rot is introduced into the interior tissues. We may consider, however, that with most of the mycelial forms of fungi their action is more or less localized, as in the smut of corn (*Ustilago maydis*), or the disease called cedar-apples (*Gymnosporangium Sabinæ*), or the curl of the peach-leaf (*Exoascus deformans*). So far as they are localized, therefore, their treatment is a simple matter, since it only involves cautery or removal of the affected part. Owing, however, to their peculiar habits of growth, and the insidious rapidity with which the spores may be disseminated, they may cause a disease of the general system when the conditions of the latter are favorable. But it is not such an easy matter to dispose of all these organisms. In the animal, it is now well demonstrated that disease may be directly produced by the action of certain schizomycetes, such as the micrococci and allied germs; and it is even claimed by some that they have a corresponding pathogenic function in the vegetable organism. These latter views, however, rest upon insufficient evidence at present; but, in considering certain diseases of plants at least, analogy would dictate measures of caution in formulating an opinion which wholly disregards the importance of these minute structures as pathogenic agents. Whether actually the cause of disease, or only of secondary features, in either case they are most difficult elements to deal with.

The third class embraces a variety of causes which may be directly controllable by man or not. Injuries may be inflicted by insects, as so generally occurs in the formation of galls upon leaves; in the punctures which various boring insects, as the *scolytus* and *ægeria* make for the deposition of their eggs; and, more especially, as in the subsequent action of the larvæ. There are, also, injuries which may be inflicted by animals and man, either by accident or design, and which permit the operation of fungoid growths with the development of secondary features. All these are of a strictly local nature, and the question whether or not the entire system will be involved in disorder must largely depend upon the extent and nature of the injury in the first instance.

The treatment may or may not be difficult. Where insect action is strictly local, as in galls, the amputation of the parts is sufficient; but, where the injury is inflicted by boring larvæ, the grub must first be destroyed, and this requires certain knowledge of the habits of these insects in the different stages of development. In the case of the scolytid borers the treatment is especially difficult, as the beetles are very small, and hard to destroy; but it is an interesting fact that the ovipositing of these insects is in itself indicative of an already diseased condition,* so that the surest and best remedy is a

* Professor Riley tells me that, so far as he knows, these borers oviposit *only* in diseased trees, though they may feed on healthy trees; and, in my observations of the last two years, I have been unable to collect a single fact opposed to this view.

complete destruction of the plant or tree, together with the borers, by fire.

Where injuries are inflicted by man, proper attention in caring for the injured part will prevent the introduction of disease. Nature provides means for the healing of injuries produced in this way, and in many cases it is possible for very extensive injuries to be healed without any aid beyond Nature's own efforts. Grape-vines and other vigorously growing plants often exhibit a most remarkable recuperative power. One of the most notable instances of this kind was brought to my attention in 1874.* During the early spring the bark of a weeping-willow was removed from the base of the trunk, making a complete girdle for a distance of eighteen inches from the ground. In some places the cambium tissue was not fully destroyed, and this materially aided in the healing process. From the upper part of the girdle, or, more properly, from the lower portion of the uninjured bark, a new growth was rapidly formed and pushed downward, soon taking the form of aërial roots. In one or two instances these became more or less connected with the trunk over the girdled portion, but most of them remained distinct, and all finally penetrated the soil, with which they established a normal connection. In another instance, when removing some young squashes from vines under experiment, the former were separated by a knife, but left in place for collection at a later time. One, however, was overlooked at the time of collection, and, when the final harvest was made, it was discovered firmly united to the stem from which it was originally separated, and had attained considerable size. Upon careful examination of the parts, both externally and under the microscope, it appeared that—1. When the cut was made the squash was not displaced, and the cut surfaces immediately came together again. 2. As determined by a "fault" in a crack of the epidermis, the squash rotated in position as the cut was made, thus accomplishing a displacement of nearly one quarter of an inch on the surface of a stem three quarters of an inch in diameter. 3. The healing was complete in the interior of the stem, but the line of section was plainly visible under the microscope. 4. The union of the epidermis and tissues immediately below was not accomplished, and there was thus left, by shrinkage of the parts, a groove which extended completely around the stem and demonstrated the completeness of the section in the first instance.

In these examples, therefore, we have illustrations of the inherent tendency of all plants to overcome disease and injury through the operation of vitality.

In soil influences we have to contend with conditions which are not always so easy to control, and, when once they have produced their effect upon the plant, the diseased condition is a somewhat difficult matter to correctly diagnose and treat. Soil influences operate in a

* "Phenomena of Plant Life," Clark.

variety of ways; it may be through excessive humidity, as determined by the stagnation of water through imperfect drainage, or the natural condition and position of the water-table, or it may be through the mechanical condition. While these conditions may not actually cause disease, they will certainly promote it when once developed, and we therefore find a certain part of remedial measures to consist in thorough drainage and cultivation. But more than this, we find in special or general exhaustion of the soil a fruitful source of disease. Lands which have been cropped for a long period become at least specially exhausted, and in such case usually in the direction of that food-element most essential to the growth of the plant which has brought about the exhaustion. There is thus developed a debilitated condition of the entire system, by means of which the normal functions are impaired, and this in itself constitutes a disease. But the debilitated state permits the operation of other forms of plant-life which would otherwise be unable to develop readily, and also allows certain abnormal physiological and chemical changes to occur, all of which promote secondary features and thus bring about complication. This, it seems tolerably certain, is the case in peach-yellows, and may also prove to be the case in other diseases such as pear-blight. Diseases developed in this way, however, are most difficult to treat, because the entire system is involved. Remedial measures must therefore be directed toward—1. Removing the cause; 2. Building up the general system; 3. Restoring to a normal condition the disordered organic function. In the case of peach-yellows, the results of chemical analysis, as well as the changes produced by special treatment, show that in all probability the specific is chlorine as contained in muriate of potash, while a general toning of the system may be accomplished by the judicious application of a complete food as determined from the ash composition.

Atmospheric conditions are largely, if not wholly, beyond the control of man. They include, of course, the varying conditions of heat and moisture, and are thus either highly stimulating and favor the excessive growth of weak structure and parasites, on the one hand, or they are depressing and cause a stagnation of vital activity, and thus injure the plants, as through excessive drought; while this, in turn, leads to the development of parasites, which would not otherwise gain a firm hold. We can not expect to modify the conditions which produce these results; we can only hope to so prepare the plant, by judicious treatment, that it will suffer no material injury from the peculiar meteorological conditions in which it is placed. With this in view, we would doubtless find it wise to apply strong food, which will retard the vegetative process, and tend to the more solid maturity of the parts already formed. Nor must we neglect the importance of a judicious course of irrigation during drought. Doubtless the time will come when every man who depends upon the growth of plants for his living will recognize a well-devised system of irrigation, which may be applied to all his orchards and cultivated fields when necessary, as an indispensable part of the machinery which a successful business demands.

The conditions which produce disease in plants, as well as the direct and secondary effects of their operation, are likely to be more or less complicated, and thus render a direct course of diagnosis and treatment correspondingly hard to reach and apply; but we can hardly form a correct estimate of these difficulties by analogy with a disordered condition of the animal. We have, at the outset, structures of widely different organization, which not only depend upon very different conditions of nutrition, but which are placed in widely different conditions of environment other than this. On the one hand, we have forms which, once developed, occupy a definite position, and their relations to environment—soil conditions, food-supply, etc.—are in a measure fixed. On the other hand, we have more highly organized bodies, which are continually changing their location, and they are thus brought into new relationships, to which they must adapt themselves, and this is liable to complicate the phases of disease already present. I think it will appear, however, that—at least in many cases, especially where nutrition is chiefly involved—we must apply the same general principles in the one case as in the other.

It was shown, not long since, by my friend Dr. Goessman,* that in certain cases of disease the normal and abnormal conditions are correlated to the presence of relatively greater and less quantities of certain food-elements. This was demonstrated by chemical analysis of the diseased wood or fruit, the naturally healthy structure, and, again, the diseased structure after being restored by a course of treatment which involved an application of the elements supposed to be wanting. In the case of the peach-yellows, concerning which we have the fullest data, he found the potash to increase in the healthy and decrease in the diseased; while the lime decreased in the healthy and increased in the diseased; and furthermore that, under treatment, the appearance of greater or less quantities of potash was reciprocal with similar changes in the lime present. The following analyses will show this relation:

CRAWFORD'S EARLY PEACH.

FRUIT.	Healthy.	Diseased.
Ferric oxide	0·58	0·46
Calcium oxide	2·64	4·68
Magnesium oxide	6·29	5·49
Phosphoric acid	16·02	18·07
Potassium oxide	74·46	71·30
Total	100·00	100·00

* "Transactions of the Massachusetts Horticultural Society, 1882."

BRANCHES.	Healthy (restored).	Diseased.
Ferric oxide	0·52	1·45
Calcium oxide	54·52	64·23
Magnesium oxide	7·58	10·28
Phosphoric acid	11·37	8·37
Potassium oxide	26·01	15·67
Total	100·00	100·00

It has further been shown by myself * that in some cases of disease, notably the one just referred to, there are important modifications of cellular structure and cell-contents as typical of the pathological condition. The growth becomes depauperate as a whole, and also in the various anatomical elements of the structure. At the same time the foliage assumes an abnormal color, and fails to perform its functions in the assimilative process. Yet, again, with reference to the storage of assimilated material, there is often an abnormal accumulation of such elaborated food in parts where it should not appear, except in limited quantity.

All these conditions in the case of peach-yellows are coincident with the development of the peculiar chemical conditions as noted above ; and it is further a most interesting fact that, while the excess of lime and want of potash occur together with depauperate structure, loss of color in the foliage, and excessive storage of starch, an increase of the potash and decrease of lime occur simultaneously with a disappearance of these various abnormal conditions.

We are now led to inquire as to the proper course to pursue in making a diagnosis.

When the disease is strictly localized, as when produced by injuries, or by the action of parasites proper; when the local disturbance is of sufficiently recent origin to render it improbable that the general system has become involved—then the diagnosis is in most cases a simple matter, and chiefly involves the correct recognition of the cause of the disturbance—i. e., the name and character of the insect or parasite, or the particular means by which the injury was first inflicted.

When the disease involves the entire system, and the conditions become more complicated, then the difficulty increases. A correct and complete diagnosis can then be made only when we consider—

1. The chemical composition in health and disease.
2. The internal features, including the—
    (*a*) Cellular structure.
    (*b*) Cell-contents.
    (*c*) Presence of fungi in the cells.
3. The external features, embracing the—
    (*a*) Color and size of the foliage.

* "Transactions of the Massachusetts Horticultural Society," 1882.

(*b*) Color and general condition of the bark.
(*c*) Character of the new growth.
(*d*) Condition of the fruit.
(*e*) Presence of parasites.

We can not hope to correctly determine the nature of diseases by seeking new light upon strictly botanical grounds alone—e. g., by assuming that they originate more or less directly in fungoid growths. Nor can we hope to get at the origin and cure of these disorders from a purely chemical stand-point. The two lines of inquiry must be followed together until they merge in one harmonious result. In such manner alone may we hope in the future to solve the difficult problems now awaiting the patient student, to whom they will bring abundant reward.

These thoughts are offered as a mere outline of the direction which such considerations in vegetable pathology are now taking, and of the form they have already assumed.

ADAPTATION TO CLIMATE.

By Dr. A. BERGHAUS.

ANIMALS and plants are fitted by their organization to adapt themselves to many changes of place and vicissitudes of climate. Most of the domestic plants that are cultivated in the north originated in southern regions. The trees of the orange family were not cultivated in Italy in Pliny's time. The citron was not raised there with success till the third century; and lemons and oranges, which now grow in Southern Tyrol, not till later. The mulberry, which has now made its way to Norway, likewise did not flourish in Italy when Pliny wrote. Juicy peaches were not grown in Greece in the time of Aristotle, and even in Rhodes the blossoms only developed into a thin, woody fruit; but the peach-tree, bearing choice fruit, is now common through all France, and in the gardens of Central Germany. Chestnuts, originally at home only in warmer Asia, are now equally so in Italy and Western Germany. Some plants, notably the cereals, have enjoyed a very extensive diffusion in the course of centuries, and are now cultivated in nearly every part of the habitable earth. Our domestic animals, which mostly came from Asia, have gone with man to all the quarters of the world; and it is worthy of note that it is just those cereals and domestic animals that have proved themselves most useful to man, and are essential to civilized life, that pre-eminently possess the faculty of adapting themselves to all climates, and of producing the most diversified varieties.

The power of adaptation to climates appears to be most highly developed in man. He is less than any other being bound to any particular zone, and is further suited to the widest diffusion, because, confined to no especial food, he is, in the fullest sense of the word, omnivorous. He is, not only by the organization of his body, but especially by his mental power and his energetic will, fitted above all other creatures to accommodate himself to the most various influences that can affect him from without, and by continuous habitude to endure or make bearable the strangest conditions. He can live at the extreme limits at which organic life can exist, and can sustain a degree of cold at which quicksilver freezes. Thus, three Russians lived for seven years in Spitzbergen without suffering in health. Admiral Wrangell, while in the Chuckchee country in 1820, experienced a cold of nearly 50° below zero, while his men were as lively and happy as if it had been summer; and Parry and Franklin withstood a still greater cold. Man can also sustain an almost incredible degree of heat. The celebrated physician, Boerhaave, believed that no being breathing with lungs could live in an atmosphere having as high a temperature as that of the blood. According to this dictum, one ought to die at a temperature of 100°, but Banks enjoyed good health on the Senegal when the thermometer rose in his cabin to above 120° and 130°. Men live on the southwest coasts of Africa, and in other hot regions, where the heat of the sand under their feet reaches 140° or 150°. Men in deep mining-shafts and under diving-bells are able to support an atmospheric pressure of 30,000 kilogrammes as well as a pressure of only 8,000 kilogrammes on the highest mountains. Cassini thought that no animal could live at a greater height than 4,700 metres, or 15,000 feet; but there are several inhabited places situated at a still greater height, as, for instance, Gartok, in the Himalayas. Alexander von Humboldt ascended Chimborazo to a height of nearly 6,000 metres, or 19,286 feet, without suffering any harm. The pressure of the atmosphere is so light at such elevations that, as Humboldt was assured, wild animals when driven up to them bleed at the mouth and nose. Only the dog is able to follow man as far and as high as he can go; but this animal, too, loses his acute smell in Congo and Syria, and the power of barking in Surinam and at great heights; and the finer breeds of dogs can not long endure the conditions of a height of more than 3,760 metres, or 12,500 feet, while there are towns in the Andes at as great a height as 13,500 or 14,000 feet.

But there are regions in which even man perishes, to whatever race he may belong, and however well prepared he may be to resist their deadly influence. Among such regions is the Gaboon valley, in which even the negro is disabled. The inhabitants of that district are decidedly weaker in constitution, and have greatly diminished reproductive powers, and the women are considerably in excess. There are similar regions nearer the centers of civilization. The Tuscan Maremma is famous for its deadly air, and the swamps of Corsica are of like character. In France the ponds of the Dombes and the mouth-country of the Charente were, till recently, no less dangerous. Life in great cities also seems to exercise a special influence on reproduction. Boudin could not find any pure Parisians who could trace the residence of their ancestors in the city back for more than three generations. In Besançon the "old families" generally die out in not quite a hundred years, and are replaced by families from the country; and the same is, to a greater or less extent, the case in London, Berlin, and other large cities.

Has it been proved that on ships, where men are crowded together for months under conditions incompatible with health, particular disorders are developed, to which sailors may, indeed, gradually accustom themselves, but which are apt to mature into fatal maladies among people hitherto in perfect health? Can we, as Darwin suggests, ascribe to such circumstances the fearful mortality and the diminishing fruitfulness of the Polynesian races? Does the consumption which has become epidemic and hereditary in those islands belong to the diseases that have insinuated themselves there by the aid of European sailors? Neither the land nor the sky has changed since the Polynesian archipelagoes were discovered; yet the aboriginal population is diminishing at a really frightful rate, while its bastard offspring and the pure Europeans are increasing rapidly.

To what extent the more or less pronounced dangerousness of a locality is affected by normal conditions or by casual injurious influences is not always easy to estimate. The character of the soil, a higher or lower temperature, dryness, and moisture, are not all that determine the character of a country. We have evidence of this in the fact that the process of acclimatization is not equally easy in both hemispheres. The white races fare much better in the hot countries of the southern hemisphere than in the corresponding latitudes of the northern hemisphere. Between the thirtieth and thirty-fifth parallels of latitude lie Algiers and a part of the United States—regions in which the acclimatizing of Europeans is attended with great difficulties. In the southern hemisphere, the southern part of the Cape Colony and New South Wales lie between the same parallels, and in those countries white men thrive. French and English troops exhibit a rate of mortality eleven times as great in the northern as in the southern hemisphere—a striking difference, which appears to depend upon the greater frequency and intensity of miasmatic fevers. North of the equator these fevers reach in Europe to the fifty-ninth degree of latitude, while south of the equator they seldom extend beyond the tropic and usually do not reach it. Tahiti lies under the eighteenth degree of south latitude, and is free from fevers. French and English troops stationed in the southern hemisphere afford a mean of 1·6 per thousand sick with fever annually, while among those stationed in the northern hemisphere the proportion of fever-sick is 224 per thousand.

Thus miasmatic fevers are two hundred times more frequent north of the equator than south of it, notwithstanding that there are extensive regions in South America and Australia covered with standing water and exposed to a burning sun. To this may be added that attacks of fever are much less severe in the southern hemisphere. Only light fevers prevail in the great lagoons of Corrientes; how much more dangerous are the fevers of the Pontine marshes, which are, nevertheless, very far from the equator! A European can live with much greater security against the contingency of fevers on the banks of the Paraná, in South America, than on the banks of the Garigliano, in Italy.

There has been no lack of attempts and theories to explain these differences in localities that seem otherwise generally to stand under the same physical relations, but none of them have been successful. Yet it appears to be established that the greatest difficulties in the way of Europeans becoming acclimated in places where their business leads them to settle are due to the presence of swamp miasms. We know that a variety of conditions must combine to produce such miasms, and we know also that man is able to contend against them. It is possible for man to open a campaign against Nature wherever he goes, and to introduce conditions more favorable to his becoming acclimated. But he has so far not been able to bring a whole country immediately into a healthy condition; only time seems to be competent to bring such a work to completion, and, waiting its course, numerous victims have to be offered up.

The cultivation of the eucalyptus, a tree of remarkably quick growth, appears to be one of the most effective means now available for improving the condition of unhealthy localities. There are frequently tracts of limited extent in the most sickly regions where the process of acclimatization is relatively easy and secure. Such points should always be chosen by new settlers. The contrary has generally been the case. The beauty and fertility of the alluviums at the mouths of rivers, with the conveniences they offer to trade, have generally been tempting enough to determine the location of the settlement, regardless of its qualities with reference to health; and towns have been planted in such places in consideration of the apparent value of the money-investment, but in complete forgetfulness of the immense capital in human lives they are destined to swallow.—*Translated for the Popular Science Monthly from Das Ausland.*

GLASGOW'S BANDY-LEGGED CHILDREN.

By GEORGE HAY, M. D.

LAST summer the writer crossed the Atlantic and visited his native country, Scotland. His parents, now well advanced in years, were living in Glasgow, and he found himself at home. On the first Sunday after his arrival he took an extensive walk through the city, and, of course, observed the people, young and old, male and female. He noticed very few good-looking men or women in Glasgow. The men are, for the most part, short and squat, while the women are undersized, and anything but handsome. The people of both sexes physically differ entirely from the men and women of Edinburgh, who, as a rule, are straight and strong, well-featured and intelligent, and excellent examples of manly and womanly beauty. The principal industry of Glasgow—the building of iron and steel ships—demands a great deal of unskilled or rather of low-grade labor, and the ranks of the laborers are recruited from Ireland. Thousands of Irishmen are employed in this work, and earn very high wages—from twelve to fourteen pounds sterling in two weeks. The average riveter is a mere animal, given to eating, and drinking, and debauchery, and, as a consequence, despite his high wages, he is continually on the ragged edge of poverty, misery, and destitution. Of course, there are some exceptions to this general rule, and they soon become independent.

If, choosing some fine day when children are apt to be on the streets, we take a walk of a single mile in any direction in the city, we are sure to notice from fifty to one hundred children, between the ages of two and thirteen years, whose legs are deformed and distorted in ways which are remarkable, and to degrees which are really hideous. One would think that the whole juvenile population was suffering from rachitis or from osteomalacia. The lines in the annexed figures, in pairs, indicating the general contour of the leg and foot, will convey some notion of the deformities, of which hundreds of living examples may be seen on the streets of Glasgow. The short, straight lines, at the bottom of each pair, indicate the feet. It is generally the bones of the lower limb from the knee downward, the tibiæ and the fibulæ, which are bent in the manner indicated in the drawings, in which care has been taken to avoid exaggeration.

In addition to those here illustrated, examples may be seen of forward or backward, regular or irregular curvature, single or double curvature of one leg, with an outward or inward, regular or irregular, single or double curvature of the other leg. In short, the legs of Glasgow children may be seen twisted and distorted in every imaginable direction. Some of these deformities are painful to look upon, though

Fig. 1.—Front View—Outward Regular Curvature.

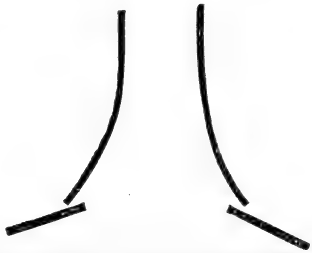


Fig. 2.—Front View—Inward Regular Curvature.

Fig. 3.—Front View—Outward and Inward Regular Curvature.

Fig. 4.—Front View—Outward Irregular Curvature.

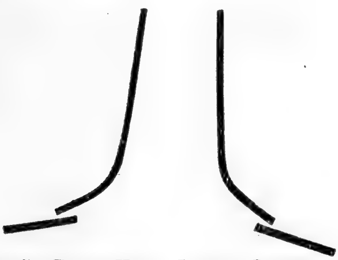


Fig. 5.—Front View—Inward Irregular Curvature.

Fig. 6.—Side View—Forward Regular Curvature.

Fig. 7.—Side View—Forward and Backward Regular Curvature.

Fig. 8.—Front View—Double Curvature of both Legs.

from a professional point of view extremely interesting. The causes assigned by the people of Glasgow for the prevalent deformity are various, but none of them seem to account for it.

Let us consider the professional opinion first. Many of the physicians in Glasgow account for the rachitis, or osteomalacia, by laying the blame upon the water which is supplied to the city. The water comes from Loch Katrine, the lake made famous by Sir Walter Scott in "The Lady of the Lake," and is very pure and soft, containing, if the writer remembers rightly, only about half a grain of solid matter in the gallon, which solid matter consists mainly of silicic acid and a little humus in solution. It is particularly free from the lime salts which go to the formation of bone; but, even though that is the case, such an attempt at explanation displays an astonishing amount of physiological ignorance on the part of those who make it. A half-ounce of bread, more or less, additional in the diet, would make up for all the difference between a soft and a hard water. The professional opinion may, therefore, be rejected as not pertinent.

Another explanation was suggested to the writer by the Professor of Physiology in the University of Glasgow, who thought the curvature of the bones of the children was due to the abandonment of oatmeal as an article of diet by people whose ancestors were accustomed to its use, and to the substitution of wheat-bread. This seemed to be a very plausible opinion. But it can be objected that, in many places where oatmeal is hardly ever used, rachitis and osteomalacia are comparatively rare. For example, in the United States oatmeal has been comparatively little known as a food, and yet very few rachitic children are to be seen. Similarly in Edinburgh, so far as the writer could observe, oatmeal is much less used than formerly, and yet the diseases in question are not evidently on the increase; and in England, in many places where oatmeal is only considered fit food for horses, no cases of rachitis or of osteomalacia were observed. Furthermore, the ash of wheat yields more phosphoric acid than that of oats—the former contains 49·81 per cent and the latter only 43·84 per cent of that substance. It is true, however, that the ash of oats contains more lime than the ash of wheat; but then wheat contains quite enough of lime to build up bone-tissue—hence the fact that certain people do not build up sufficient bone-tissue, no matter what their diet may be, is proof that the diseases are due to a tendency in the individuals to waste, and not to assimilate these very phosphates which wheat-flour contains in abundance. This explanation, also, must therefore be dismissed as insufficient.

Another opinion ascribes the deformity to the peculiar method of carrying their babies in vogue among the women of Glasgow. A large shawl or plaid is wrapped over one shoulder and around the waist of the mother, with one turn around the baby, which is additionally supported by sitting on the mother's arm. This is a very convenient way of carrying a baby—almost as convenient as that adopted by some savage tribes, whose papooses are borne in a basket slung over the mother's back. It is only employed when the mother is out on an errand; and, though the child's legs, of course, are somewhat constrained by the shawl, the actual time during which that is the case amounts to very little in the twenty-four hours, and is not long enough to produce the deformity. Moreover, not many miles away, at Saltcoats, on the Ayrshire coast, all the women carry their babies in precisely the same manner as in Glasgow, and yet not a single case of rachitis or osteomalacia is to be seen there. The people of Saltcoats, however, are Scotch. The same method of carrying babies is quite common over all the south and west of Scotland, yet nowhere else in the country, except in Glasgow, are so many horrible cases of rachitis or of osteomalacia to be seen.

Some persons, observing that many of the Glasgow mothers, whether married or unmarried, are workers in the mills — cotton, woolen, linen, and jute mills—are of the opinion that there is something in their employment that promotes bandy-leggedness. But, so far as I could observe, the children of such women were no more rickety than the children of women in other occupations. The mills in Great Britain are, so far as their hygienic condition is concerned, far better provided for than the mills of any other country in the world; they are looked after by the Government, and regularly visited by a competent and responsible inspector. Mill-workers have, nowadays, an easy, comfortable, and healthful occupation, and really there is nothing in mill-work to deform or injure either the women or their children.

Many lay the blame for the trouble upon the air. Glasgow air does not appear to be different from other air, and is certainly no worse than that of a dozen other manufacturing cities where no unusual bandy-leggedness exists. Consideration of this point may, then, be dismissed at once.

The writer believes that an adequate explanation for the affliction may be found in the habits of the Irish people. It is well known that all over the south and west of Ireland thousands of the peasantry live in mud cabins, which are for the most part several feet below the level of the surrounding soil, many of them destitute of windows, doors, and chimneys, the places of which are supplied by simple holes. The cabins are warmed by a peat-fire in the center of the burrow under the hole in the roof. The fuel is got from the adjacent bog, and its smoke would speedily blear and blind the eyes of any stranger who might venture to go inside. Such holes are continually damp, and are hot-beds (or rather *cold* beds) of rheumatism, rickets, osteomalacia, and various other diseases. There are generally half a dozen or more miserable children, huddled together for mutual warmth in the cold months, along with the parents, in addition to whom there is generally at least one full-grown pig, with perhaps a litter of young ones. The food of the family consists chiefly or entirely of potatoes, and it is seldom indeed, that any of the members see bread or meat, although occasionally a little fish, in the shape of eels from the adjacent "bog-holes," may find its way to their mouths.

According to Marshall ("Human and Comparative Physiology"), "potatoes are a weak food, one pound being only equivalent to about six ounces of bread, or four ounces and a half of lentils; they are not much more nutritious than the succulent vegetables." It follows that, in order to support the body at all, enormous quantities must be eaten. The stomach expands to accommodate the huge bulk of this inefficient food, the body becomes paunchy, and the limbs of children, enfeebled by rachitis, occasioned partly by the miserable food and partly by the unwholesome surroundings, bend under the weight of the trunk, and the deformity already described is the result. The writer remembers distinctly the time when large bands of Irishmen used to visit England and Scotland, during the autumn of each year, to be employed on the harvest-field as shearers or reapers. But, owing to the introduction of machinery, that occupation is gone. The harvest only employs men for a few weeks each year; but the building of iron ships is carried on all through the year: the shearers have become riveters, and have remained in Glasgow. The late Hugh Miller, describing those reapers, wrote thus: "Pot-bellied and bow-legged, and with scarcely a rag to cover them, these wretches walk abroad into the daylight of civilization, the annual apparition of Irish ugliness and Irish want." The vice of constitution, acquired in the miserable cabins of the wilds of Connaught, has become hereditary, and it is the now recognized principle of heredity which accounts for the deformed legs of the children of Glasgow. When the bones are bent at obtuse angles, the deformity is usually treated in the hospitals by fracture, i. e., the bones (both tibiæ and fibulæ) are broken at the angle, and the fracture is treated in the usual manner. This is done, however, after the bones have become hard and have assumed a permanent set.

It may be objected by American observers that the Irish in America exhibit none of these excruciating deformities. But it must be remembered that few but reasonably able-bodied Irish manage to get to America. Few others can get together the means to pay their passage; and any cripples or seriously deformed persons would be liable to be refused passage by the transportation companies, or rejected and sent back as paupers on arrival here. At this point, again, the law of heredity comes into play, for if the parents, and the children which they bring along with them, are not rachitic, the chances are that the children and children's children born in America will not be rachitic either.

SKETCH OF ABÛL-WALID MOHAMMED IBN-AHMED IBN-MOHAMMED IBN-ROSHD (COMMONLY CALLED AVERROËS).

By GEORGE JACKSON FISHER, M. D.

DANTE tells us that when he descended into the infernal regions, on arriving at limbo, which is the first and favored circle of hell, where the good and virtuous are permitted to reside, having been excluded from the bliss of paradise from neglect of baptism, he found "a sapient throng," with Aristotle, "the Master"—

"Seated amid the philosophic train";

and, when a little more he raised his brow, he "spied"

"... Hippocrates,
Galenus, Avicen, and him who made
That commentary vast, Averroës." *

It is of this vast commentator and renowned Saracenic physician that I now propose briefly to write. Averroës flourished, without a doubt, in the twelfth century; there is, however, no inconsiderable amount of uncertainty and discrepancy among authorities concerning the precise time of his birth, some placing it as early as the year 1126, others as late as 1198. The same confusion exists as to the date of his death, ranging it from 1198 to 1225. The dates (1126–1198) are believed to be as nearly accurate as can be determined at this time. By this assumption it appears that Averroës attained the age of seventy-two years. He was of an ancient and noble family, being the son of the high-priest and chief judge of Cordova, the beautiful capital city of Andalusia, in Spain. Cordova was the place of his nativity.

Leo Africanus informs us ("De Vir. Arab.," p. 280) that Averroës commenced the study of philosophy, when he was but a youth, under the celebrated Thophail, or Ibn-Tofail (Abubacer), who is the author of the noted metaphysical tale "Hai Ebn Yochdan." An English translation of this elegant story was published by Professor Ockley, of Cambridge, in London in 1711. It is not unlikely that the extreme admiration which Averroës always entertained for the writings of Aristotle was inspired by the enthusiastic teachings of Ibn-Tofail. His unbounded admiration of Aristotle amounted to a profound reverence, for thus we find Averroës asserting that "the doctrine of Aristotle is the perfection of truth, and his understanding attained the utmost limit of human ability; so that it might be truly said of him that he was created and given to the world by Divine Providence, that we

* "Inferno," Vision, Hell, canto iv.

might see in him how much it is possible for man to know." Averroës devoted a great portion of his life to literary pursuits, but chiefly to his chosen task of expounding the doctrines of his favorite author. A printed edition of his works, in ten large folio volumes, furnishes ample testimony of the extent of his labors, and fully justifies the cognomen of "The Commentator," and of Dante's expression "that commentary vast." He was also styled "the soul of Aristotle."

It has been said that he wrote his medical treatises for the purpose of reconciling the doctrines of Galen with the philosophy of Aristotle; for it is evident that his estimation of the medical philosopher of Pergamus was only second in degree to the almost veneration which he entertained for the philosopher of Alexandria.

It is not within the compass or purpose of this sketch to furnish the reader with even a brief summary of the peculiar characteristics of the metaphysical doctrines which constitute what has been termed Averroism, or to give an account of its wide-spread influence throughout Europe, and particularly during three entire centuries in the universities of Northern Italy. I will merely state that Padua became the seat and center of "Averroist Aristotelianism," and that Petrus de Apono, about the year 1300, became a famous expositor of these doctrines in their relation to medicine, and an equally noted example of heterodoxy in matters of faith; so much so that his effigy was burned in the public market-place by the executioner, at the command of the Inquisitors. Though for ages both Aristotle and Averroës were regarded as the supreme masters of the science of proof, yet their teachings were considered inimical to the requirements of religious faith; their disciples were called derisively "the people of demonstration." Later on, Erasmus and others poured out the vials of their contempt on scholastic barbarism with its "impious and thrice-accursed Averroës."

To return to his personal history. Averroës lived not long after Avenzoar, whom he calls "admirable, glorious, the treasure of all knowledge," and the most supreme in physic from Galen to his own time. Averroës was personally acquainted with the sons of Avenzoar. He was a great student. It is said that, under the most approved teachers of his time, he mastered theology, jurisprudence, mathematics, philosophy, and medicine. He flourished at a time when the Moslem caliphate in Spain had attained its maximum splendor, and such as had only been excelled by the ancient Oriental glories of Arabia and Persia. Cordova was the Bagdad of the Occident. Averroës worshiped in great and magnificent mosques, attended schools and colleges of erudition and renown, consulted libraries vast in extent, rich and rare in quality; walked large hospitals, whose cases supplied ample illustrations of all the mortal ills to which our poor humanity is subject; and, having been introduced by Ibn-Tofail, the philosophic vizier of Jusuf, to that prince, he possessed every requisite qualification and influence to insure success and distinction in life. Averroës, being master of the Melekitic law, was appointed cadi of Seville in the year 1169, and for a quarter of a century occupied his time in similar offices in Cordova, Seville, and Morocco, belonging at the same time to the court of the reigning monarch Jusuf Almansur, who, it is said, was fond of engaging him in philosophic discussions in relation to the Islam faith.

The profound acquirements which he had made in all departments of learning, and particularly in scholastic philosophy, by which the name of Averroës had become famous, eventually resulted in his almost total ruin. He was accused of heresy, and his teachings were declared to be inimical to Moslem faith.

The charges were signed by a hundred witnesses, who testified that they had listened to heresies uttered from his own lips. The Caliph's fears of the populace, in a matter so vital to their religious belief, overpowered his love for Averroës, and drove him to rigid measures. He confiscated his property, deprived him of honors, offices, and emoluments, and banished him to a place outside the walls of Cordova, there to dwell with the Jews and other outcasts in the suburbs. Africanus goes on to say that the boys used to watch the opportunity of his going up to the city, at the hour of prayers, to pelt him with mud and stones. Such was the force of the fanatical indignation against poor Averroës, that everywhere he was subjected to the jeers and insults of a bigoted populace. All this occurred about the year 1195, at which time a general effort was made to destroy all liberal culture in Andalusia, reserving only such practical branches as would prove most useful to the people, including medicine, surgery, mathematics, and astronomy.

From all these misfortunes, ignominy, and degradation he at length escaped, and betook himself to Fez, whither he was soon pursued, arrested, and committed to prison. The royal council could not agree concerning the issue of his fate. Instant death was demanded by some, while others insisted on permitting him to live, and extorting from him a public recantation of his errors. The final decision was that he should be led out bareheaded, at the hour of prayer, and placed on the upper step at the entrance of the mosque, that every one as he passed in might have an opportunity of showing his holy wrath and indignation by spitting in the heretic's face. It is said that this contemptible treatment was submitted to with stoical indifference. When the service was ended, the judge and officers of the court came forward and listened to a public confession of his alleged heresies. Averroës was then permitted to return to Cordova, where he entered in privacy, and remained in poverty, rags, and wretchedness ; scorned, neglected, with none for associates but the most degraded classes of society. Great, indeed, was the fall of Averroës ! The limbo of Dante must at last have proved to him a paradise indeed !

This poor philosopher had not yet reached the end of his eventful life. Owing to the misrule of his successor in the regency of Morocco, the discontented people earnestly petitioned the ruler of the Faithful to restore their former governor, whose mildness and wisdom had secured to them so high a degree of prosperity and so many blessings. After much deliberation Averroës was restored to freedom, reinstated in his positions of honor, where his moral virtues, his amiability, his justice, and his humanity, were exercised to the advantage of his fellow-beings. He secured the love, the applause, the admiration, and gratitude of the people over whom he ruled, and we are told that happiness gilded the evening of his days, his sun sank gently beneath an unclouded horizon, and his memory was a radiant halo, not unlike the roseate twilight that sometimes lingers along the western sky, the charming influence of which can only be felt and contemplated with emotions of grateful delight. And thus it was that Averroës closed his eventful life in the year of grace 1198, being but about a twelvemonth previous to the death of his patron Almansur, with whom the political power of the Moslems terminated, as did the study of the liberal sciences with the death of Averroës.

He was evidently a man of dignity, rectitude, and nobility; a wise and humane judge; a devoted student; a profound scholar; and, though surrounded by the luxuries of a royal court, yet simple, temperate, almost rigidly abstemious in his mode of life.

As a medical writer Averroës was the author of two works which are still extant; one being the "Koullyath," or "Kulliyyat," which is better known as the "Colliget" or "Summary"; the other is a commentary on the medical poem or *cantica* of Avicenna. The "Colliget," which is his principal work, was dedicated to Abdelech, the Miramamolin of Morocco, and contains a digest of the whole science of medicine, being divided into seven books. It contains but little that is original, though we find him speaking of his own experiences. He is said to be the first to state that small-pox occurs in the human constitution but once in a lifetime. His anatomy is copied entirely from Galen. His commentary on the *cantica* of Avicenna was considered to be the best introduction to medicine that had ever appeared.

Some time ago I picked up a curious little duodecimo entitled "Averroeana," being a transcript of several letters from "Averroës, an Arabian philosopher at Corduba, in Spain, to Metrodorus, a young Grecian nobleman, student at Athens," in the years 1149 and 1150. Also "several letters from Pythagoras to the King of India," etc., etc. "The whole containing matters highly philosophical, physiological, Pythagorical, and medicinal. The work having been long concealed, is now put into English for the benefit of mankind, and the rectification of learned mistakes." London, 1695.

P. Grinau tells us, in his prefatory letter, that his friend Petit, who had for many years resided in Andalusia, gave him the book, which he says was written by Averroës's own hand, and that it had long lain in the library of a certain nobleman in Andalusia. It deals with many curious physiological questions, and furnishes proof that Averroës was a practicing physician. Space will not permit me to make extracts from the work, though, in passing, it may be mentioned that he speaks of his own experiments and experiences; for example, he discourses at length on the value of milk in the treatment of pulmonary consumption.

The library of the Escurial in Spain still contains in manuscript among its treasures the greater part of the writings of Averroës, particularly those on jurisprudence, astronomy, essays on special logical subjects, and his criticisms on Avicenna and Alfarabius. Other manuscripts are preserved in European libraries. The Latin editions of the works of Averroës have been very numerous. The first appeared at Padua in 1472; about fifty were published at Venice, the best known being that by the Juntas in 1552–'53, in ten folio volumes. During the century from 1480 to 1580 no less than one hundred editions were issued. This fact attests the exalted estimation in which his works were held. None were ever printed in Arabic. The "Colliget" was first printed in 1482, at Venice, in folio; also in 1490, 1492, 1497, 1514, 1542, and 1552. The commentary on the "Canticles" of Avicenna were printed in nearly as many editions, and often with the "Colliget."

Should the reader desire to know more of the philosophy and theology of Averroës, he may be gratified by consulting either or both of the following treatises: Renan, "Averrhoès et l'Averrhoisme," Paris, 1852; and Müller, "Philosophie und Theologie von Averrhoës" Munich 1859.

What authority there may have been for the portrait of Averroës by Raphael, now in the Vatican, I am quite unable to state. The writer has a fine old print, on a folio sheet, of this portrait, engraved by P. Fidanza. It is done in bold pen-and-ink-like strokes, being an Arabian head covered with a massive turban, a face of earnest but fierce expression, more suggestive of a Bedouin chief than of a profound philosopher.

The frontispiece in the present number of the "Monthly" is a reduced copy of this rare engraving.

EDITOR'S TABLE.

THE SURVIVAL OF POLITICAL SUPERSTITIONS.

As explained by the law of evolution, progress is the result of slow transformations in the parts of adaptable organisms under changed conditions. Still, influenced by the old ideas that things were once suddenly created and may be quickly changed, we fail to appreciate the slowness of the modifications that take place, and how tenaciously old things survive and live on in their essences, with only sufficient alteration to justify the introduction of new names.

We see this strikingly illustrated in the history of government. There is an enormous overvaluation in the import of their changing forms. It was, of course, a great event when we of this country, a hundred years ago, repudiated formal monarchy, and its aristocratic and hierarchical appendages, and adopted republican government in its place, but the real value and extent of the change have been in many respects much magnified. Fundamental ideas of the old order of things continue in vigorous operation, with but very superficial modification of character.

For thousands of years the conceptions of government and of kingcraft were identical. Nations appeared and disappeared in the march of history; empires rose and fell, systems of religion and systems of philosophy succeeded each other, knowledge augmented and the literary arts were perfected in their different types, and great civilizations unfolded and passed away, and all this while the forms of government continued monarchical, and human society was governed by the superstition that kings represent the gods and are infallible. The overshadowing and persistent superstition was that government was supernaturally organized, and that kings ruled by right divine. We look upon this idea now as a mere curious vestige of an empty illusion of ages of ignorance, but it was an idea of living application and tremendous power. Men religiously believed in it and thoroughly acquiesced in it. It was broadly asserted alike by the occupants of thrones and by the classes authorized to teach the people, and they accepted it as fundamental and sacred political truth. The open avowal of this doctrine comes down to quite modern times. The standard of loyalty exacted by the sovereign was thus laid down by King James, the translator of the Bible: "As it is atheism and blasphemy in a creature to dispute what the *Deity* may do, so it is presumption and sedition in a subject to dispute what a *king* may do in the height of his power; good Christians will be content with God's will revealed in his word, and good subjects will rest in the king's will revealed in his law."

It is not yet two centuries since De Foe could write in England as follows: "It was for many years—and I am witness to it—that the pulpit sounded nothing but absolute submission; obedience without reserve; subjection to princes as God's vicegerents; accountable to none; to be withstood in nothing and by no person. I have heard it publicly preached that, if the king commanded my head, and sent his messengers to fetch it, I was bound to submit, and to stand still while it was cut off."

Now, it is not to be supposed that so deep and long-established a sentiment, by which the lives of generations were regulated, was to be extirpated from human nature, and dismissed to annihilation in any short period of time. Some features of it might fall away and be repudiated, and it might be thus transformed, but transformation itself implies the living on of the essential thing in modified shape. Nor can we say that that which has been eliminated and has passed away is simply the superstition, while the surviving element is some truth of reason which was disguised under the old expression. Under a less gross and palpable form the superstition itself continues, and for the divine infallibility of the king we have a superstitious belief in the practical infallibility of Congress and the political majority. "The king may do all things by divine right, and we are bound to obey," was the old formula; "the political majority may do all things in its sovereign pleasure, and everybody is bound to obey," is the derived formula of the present time.

The supernatural element in the case is undoubtedly gone, but the blind and unreasoning faith which is the essence of superstition is the survival which is still to be dealt with. What is the ground of the authority of government? In what does its sovereignty consist? Is it supreme and unlimited, or is it subject to restriction? And, if so, what are the principles of limitation? What may government do and what may it not do? What is the fundamental right and wrong of government action to which all legislation is bound to conform on imperative ethical grounds? These are questions that are forced upon the age with a steadily increasing urgency, and the answers to which are of transcendent importance to the future progress of society.

These questions are besides of especial and critical moment in this country, where the whole community is launched upon the turbulent sea of politics, and there is the highest possible need of distinct and trustworthy politico-ethical guidance. That the subject receives little serious attention on the part of our ignorant and self-seeking politicians, occupied with their paltry schemes of partisan rivalry, matters little except to impose graver obligations upon serious-minded people. The degradation of popular government in this country to the basest ends of demagogism, the tendency to rule out all questions of principle as disturbing elements in the great game of partisan success, the surrender of Legislatures to the promotion of sordid class interests, and the universal negelect of the true objects of government, while its illegitimate objects are everywhere vehemently pursued—all this is sufficiently notorious, and it marks out the definite work of our political reformers in the future. The present state of things is not a finality, and there is no justification for despair of salutary political progress. The passage from superstition to reason is slow and unsteady, but it is inevitable. Government is not to be run forever on fallacies and by political quacks. We are in a time of transition, which is always painful and discouraging, but tendencies are at work, and are slowly acquiring strength, which are certain to make headway against the errors and vices of the prevailing political system. It is of course very easy to be over-sanguine, and to form delusive expectations of good to be attained, and there is especial danger of this in politics, where it is expected by changing a vote or passing a law to get great results in a short time. But political renovation can come by no such superficial means; we must have a revolution of ideas, resulting in sounder views of the nature, authority, and scope of government; and that this will come in its proper time, and give rise to a new departure in politics, is no more to be doubted than we can doubt the continued activity of the human mind, the further growth of scientific thought, or the many improvements and ameliorations that have been already accomplished.

Meantime, the work to be done is simply to diffuse among the more intelligent classes of the community those deeper social truths and sounder political principles which have been worked out by patient and powerful intellects who have prized and sought the truth above all other things, trusting implicitly that better knowledge will at length yield the desirable fruits of better practice. This has been the policy of "The Popular Science Monthly." We are interested in politics, but only in that regeneration of politics which will make its pursuit more honorable, its objects more noble, and its influence upon society less corrupting and debasing, and more elevating and beneficent. We have frequently published articles animated by this spirit and purpose; and have been led to the foregoing remarks by a desire to call attention to the instructive and valuable article which opens the present number. We commend this discussion of the important but neglected subject of political ethics to the careful perusal of all who are interested in the solution of the most pressing political problems of the time.

PRESIDENT ELIOT ON LIBERAL EDUCATION.

The address of the President of Harvard University, entitled "What is a Liberal Education?" delivered in February, before the members of the Johns Hopkins University, and published in full in "The Century" magazine for June, is a contribution to the subject so able, advanced, and independent that it deserves to be carefully read by all who are concerned in higher educational reforms. The article has great and peculiar value, because it has been produced under the pressure of grave responsibility, and presents views which have been subjected to every critical test preparatory to carrying them out in the eminent institution of which the author is the distinguished head. It is easy to talk at random, and indulge in exaggerated statements, but we have here the cautious and measured conclusions of a wise educational policy to be reduced to actual practice. But caution here does not mean timidity. There are a firmness of tone and a boldness of treatment in this paper which show that the author appreciates the urgency of the situation, and has perfect confidence in the strength of his case. This address is therefore to be commended to all the friends of educational improvement as having the force, weight, and seriousness of an authoritative document, and for this reason we are glad to observe its appearance in a magazine of wide circulation and large influence, and we hope it may soon be separately issued and extensively distributed for effective use in the quiet campaign of collegiate reform. It is a fitting sequel and supplement to the Harvard address of Mr. Adams last year, which proved so efficient in arousing public attention to the deficient working of our American colleges, but it is a broader and more philosophical discussion of the defects and requirements of the higher education at the present time, and grapples with the wide question of there organization of the university curriculum, and the necessity of making the so-called liberal education more thoroughly liberal than the traditional system that has come down to us from the past.

President Eliot opens his argument with the remark that the degree of Bachelor of Arts, which is the customary evidence of a liberal education, needs to be defined anew, with an enlargement of its signification; and he shows, first, that, so far from being a settled, permanent, and unchangeable ideal for all time, as the devotees of the classics are so fond of maintaining, it has already undergone change after change with the progress of learning, so that the studies essential to the bachelor's degree, both in their subject-matter and in their disciplinary influence, have been radically different in the centuries that have succeeded after it was instituted. Even mathematics, which seems to be the very type of unchangeable method, he shows to have undergone nothing less than a revolution, so that that form of it, which Dr. Whewell defended as "a permanent study," has disappeared, and been replaced by another mathematics of a totally different sort. The modern analytical mathematics, "the only mathematics now in common use in the United States," is thus characterized by the Master of Trinity in contrast with the earlier geometry. He says: "We must hold also that the geometrical forms of mathematics must be especially preserved and maintained as essentially requisite for this office (the study by which the reason of man is to be educated); that analytical mathematics can in no way answer this purpose, and, if the attempt be made so to employ it, will not only be worthless, but highly prejudicial to men's minds."

In regard to another unalterable element of the disciplinary curriculum, President Eliot remarks: "It is obvious that the spirit and method in which Latin has been, for the most part, studied during the present century, are very different from the spirit and method in which it was studied in the preceding centuries. During this century it has been taught as a dead language (except, perhaps, in parts of Italy and Hungary), whereas it used to be taught as a living language, the common speech of all scholars, both lay and clerical. Those advocates of classical learning who maintain that a dead language must have more disciplinary virtue than a living one would hardly have been satisfied with the prevailing modes of teaching and learning Latin in any century before our own." Even Greek, so lauded as "an instrument for the perpetual training of the mind of the later generations," has not always been a constituent of the accepted scheme of liberal education. "It took two hundred years for the Greek language and literature gradually to displace, in great part, the scholastic metaphysics, which, with scholastic theology, had been for generations regarded as the main staple of liberal education; and this displacement was accomplished only after the same sort of tedious struggle by which the new knowledges of the eighteenth and nineteenth centuries are now winning their way to academic recognition. The revived classical literature was vigorously and sincerely opposed as frivolous, heterodox, and useless for discipline; just as natural history, chemistry, physics, and modern literatures are now opposed. The conservatives of that day used precisely the same arguments which the conservatives of to-day bring forward, only they were used against classical literature then, while now they are used in its support."

The sticklers for traditional immutability being thus disarmed, by showing that "new learning has repeatedly forced its way in times past to full academic standing, in spite of the opposition of the conservative, and of the keener resistance of established teachers and learned bodies, whose standing is always supposed to be threatened by the rise of new sciences," President Eliot proceeds to point out the imperative necessity of still further important changes that shall bring university and college studies into completer harmony with the present state of knowledge and the demands of modern life. The ground taken is thus broadly stated: "To the list of studies which the sixteenth century called liberal, I would therefore add as studies of equal rank, English, French, German, history, political economy, and natural science, not one of which can be said to have existed in mature form when the definition of liberal education, which is still in force, was laid down. The claims of these studies are taken up separately; it is shown how widely and grossly they are neglected, and their right to coequal recognition with older studies is argued with great force and entire conclusiveness. As an example of the vigor with which the claims of these several subjects are presented, we quote what President Eliot says about the study of English:

The first subject which, as I conceive, is entitled to recognition as of equal academic value or rank with any subject now most honored, is the English language and literature. When Greek began to revive in Europe, English was just acquiring a literary form; but, when Greek had won its present rank among the liberal arts, Shakespeare had risen, the English language was formed, and English literature was soon to become the greatest of modern literatures. How does it stand now, with its immense array of poets, philosophers, historians, commentators, critics, satirists, dramatists, novelists, and orators? It can not be doubted that English literature is beyond all comparison the amplest, most various, and most splendid literature which the world has seen; and it is enough to say of the English language that it is the language of that literature. Greek literature compares with English as Homer compares with Shakespeare—that is, as infantile with adult civilization. It may further be said of the English language, that it is the native tongue of nations which are preeminent in the world by force of character, enterprise, and wealth, and whose political and social institutions have a higher moral interest and greater promise than any which mankind has hitherto invented. To the original creations of English genius are to be added translations into English of all the masterpieces of other literatures, sacred and profane. It is a very rare scholar who has not learned much more about the Jews, the Greeks, or the Romans through English than through Hebrew, Greek, or Latin.

And now, with all this wonderful treasure within reach of our youth, what is the position of American schools and colleges in regard to teaching English? Has English literature the foremost place in the programmes of schools? By no means; at best only a subordinate place, and in many schools no place at all. Does English take equal rank with Greek or Latin in our colleges? By no means; not in the number and rank of the teachers, nor in the consideration in which the subject is held by faculty and students, nor in the time which may be devoted to it by a candidate for a degree. Until within a few years the American colleges made no demand upon candidates for admission in regard to knowledge of English; and, now that some colleges make a small requirement in English, the chief result of the examinations is to demonstrate the woful ignorance of their own language and literature which prevails among the picked youth of the country. Shall we be told, as usual, that the best way to learn English is to study Latin and Greek? The answer is, that the facts do not corroborate this improbable hypothesis. American youth in large numbers study Latin and Greek, but do not thereby learn English. Moreover, this hypothesis is obviously inapplicable to the literatures. Shall we also be told, as usual, that no linguistic discipline can be got out of the study of the native language? How, then, was the Greek mind trained in language? Shall we be told that knowledge of English literature should be picked up without systematic effort? The answer is, first, that, as a matter of fact, this knowledge is not picked up by American youth; and, secondly, that there never was any good reason to suppose that it would be, the acquisition of a competent knowledge of English literature being not an easy but a laborious undertaking for an average youth—not a matter of entertaining reading, but of serious study. Indeed, there is no subject in which competent guidance and systematic instruction are of greater value.

LITERARY NOTICES.

The Past and Present of Political Economy. By Richard T. Ely, Ph. D. Baltimore: N. Murray. Pp. 64. Price, 35 cents.

This is a contribution to the "Johns Hopkins University Studies in Historical and Political Science," edited by Herbert B. Adams, and constitutes No. III of the second series. The scheme of publication is an important one, but it contains no contribution more valuable than this monograph on the present condition of political economy by Dr. Ely.

There is unquestionably a good deal of confusion of mind among general readers in regard to the present condition of the so-called science of economics. While the subject continues to rank, as it has long ranked, as a branch of science with its accredited text-books, and its status in the curriculum of higher collegiate study, on the other hand many articles have latterly appeared in the graver reviews questioning the soundness of its theories, the validity of its principles, and the trustworthiness of its guidance. A reaction has set in against the old forms of economical doctrine, which long passed current, and there are many who will be glad to understand the meaning of it. Is there no such thing as a science of political economy in the established sense of the term science? Are there no ascertainable laws in the economical division of social phenomena? Is political economy a legitimate but still an imperfect science; and are the controversies that have arisen over many of its doctrines but the necessary stages of its further and higher development?

In this perplexity of inquiry, Dr. Ely comes to give us an account of the situation, to trace the history of the subject, to show the changes that it has undergone, and report upon its present attitude in the world of thought. We do not understand him as denying the possibility or even the present existence of such a science, but he assumes that diversion from the old views has proceeded so far, and become so distinctive, as to give rise to a new school, which aims to rival and replace the older expositions of the subject. He is an adherent of the new school, and of course, so far as that implies, a disbeliever in the old school, and, at the same time that he informs us, with undoubted fairness, of the features of contrast between them, he is also a strenuous advocate of the one and an adversary of the other.

The nomenclature of these parties who represent different views of political economy has become quite copious, and a reference to it will throw some light on the distinctive doctrines of the opposing partisans. The political economy which may be said to have originated with Adam Smith, and which was subsequently further developed by Malthus, Ricardo, Senior, and James and John Mill, is known as "the old school," and, as it originated in England, "the English school." With reference to the authority and wide acceptance of its teachings, it is referred to also as "the orthodox school" and "the classical school"; and, as some of the most vigorous of its propagandists had their headquarters at Manchester, it has been called "the Manchester school," while, with reference to its predominant method of inquiry, it has also been termed "the deductive school."

The rival system of political economy, which now claims attention as a "new school," is declared by Dr. Ely to have originated in Germany about 1850, being represented by three young German professors, Hildebrand, Knies, and Roscher; it is therefore known as "the German school." Protesting against the deductive character of the English political economy, and asserting induction to be the proper basis of economical method, it is known as "the inductive school"; while to bring the subject into rank with politics, jurisprudence, and theology, which are pursued by the historical method, the Germans designate it by perhaps its most characteristic title, "the historical school." It is claimed also that the new method is "statistical," "experimental," and even "physiological"—"to call attention to the fact that it does for the social body what physiology does for our animal bodies."

Dr. Ely devotes the first forty pages of his monograph to the older political economy, dividing his statement into several sections. Section I, "Introductory," offers some general remarks on the growing evidence of the unsatisfactoriness of the political economy of Adam Smith, and his English followers. Section II, "The Old School," pursues the same line of thought, with some critical examination of the leading doctrines that have characterized the English political economy. In Section III, "The Attractions of Economic Orthodoxy," Dr. Ely points out how, from the simplicity of the system, it was fitted to take hold of men's minds while they knew nothing of the real complexities and formidable difficulties of the subject. Because of its narrowness and deductive character, there came also to be great faith in the fundamental propositions of the science which were regarded as permanent truths; while the system was commended to the governing powers in state and society because things were to be left to themselves, and "no exertion, no sacrifice, was required on their part to alleviate the sufferings of the lower classes." In Section IV Dr. Ely discusses the "Merits of the Old School," which he recognizes were great, independently of the correctness of its doctrines. It did vast service as the pioneer in this field of research, and on this point we quote Dr. Ely's words: "Further, the present political economy in all parts of the world grew out of the classical political economy, and the former can not be comprehended until the latter has been mastered. It was, indeed, efforts to master, extend, and perfect the older school, as well as other causes, like later developments of industrial life, which gradually led to the most recent economic investigation. Nor does any one now doubt the continued and all-pervading—even if not all-controlling—influence of these motive powers which furnish Ricardo, Mill, and Senior, with their major premises; but this fact was not understood before the coryphei of the older political economy elucidated it, and they deserve great credit for what may be fairly termed their discoveries. It was, for example, a service of no mean order to point out all the ramifications of self-interest in economic life, to set in order the phenomena explained by this principle, and to show how it prompts men to the most diverse deeds, which, undertaken without a view to the welfare of others, nevertheless redound to the common good. And it must be confessed that no single principles have been discovered by the German school, which throw such a flood of light on the multifarious phenomena of economic life as do, for example, the Ricardian theory of rent and the Malthusian doctrine of population."

Having made these concessions, Dr. Ely proceeds elaborately in Section V to discuss "The Decline and Fall of the Old School." He objects, first, "that the whole spirit of its practical activity was negative." He attacks the doctrine of *laissez faire*, which he alleges grew out of that negative system, and has turned out to be a total failure. "It never held at any time in any country, and no maxim ever made a more complete *fiasco*, when the attempt was seriously made to apply it in the state." His chief illustrations of the break-down of this doctrine are education and the English factory system. He next arraigns "another favorite notion of the older economists, and one which leads to great hardship in real life, that taxes are shifted so as to be divided fairly between different employments in which capital is engaged." He then condemns "the supposition that self-interest is the chief force of economic life," which he maintains to be the leading premise of the English school. The doctrine of "equality of wages" is attacked as an error of the old economists, as is also the idea "of the natural laws of political economy," and the principle of "supply and demand."

We can not give the reasonings by which the older political economy is impeached in these several particulars, but their enumeration will suffice to inform the reader somewhat of the nature and extent of the indictment against the old system by which it is to be discredited and put aside to make place for another system.

In Section VI the new school is taken up and its various claims presented. Chief among these are that facts and statistics are to be more studied, that there is to be greater caution in theorizing, and especially in the use of deduction; and, above all, that the subject is to be dealt with historically. It seems to be denied that there are any principles of political economy to be taken as fundamental or universal, or as fitted to form the body of a science to be generally accepted like other sciences. The subject is said to involve changed conditions and constantly changing policy. "It is found that the political economy of to-day is not the political economy of yesterday, while the political economy of Germany is not identical with that of England or America. It is on this account that knowledge of history is absolutely essential to the political economist."

Now, while Dr. Ely's statements of the general case are most interesting and instructive, we can hardly acquiesce in the validity of his argument. Much of his criticism of the older political economy may be taken as well-based and wholesome, while his argument is overdone. We may freely concede that the earlier expositions of political economy were imperfect, and that much of its subsequent literature is open to objection. But science is self-corrective in time, and the labor of generations is necessary for the development of its principles, especially if they are of a complex kind, and dependent upon the advance of other sciences. But the foundations of the old political economy were well laid; the method was broad, valid, and as productive of important results as research in any other field. The correctness of the procedures has been attested by the discoveries of economic laws, worked out, if not into their final forms, at least into such clearness and certainty as to give them value for practical guidance. Granting that there is much need for revision, amendment, enlargement, what is this but the common condition of all progressive knowledge? To speak of the "decline and fall" of the English school of political economy savors of exaggeration, and seems no more proper than to speak of the decline and fall of any other branch of science when its errors are discovered, and it passes to a new stage of its development.

Dr. Ely, as we have seen, charges that the whole spirit of the old school is negative. "It was powerful to tear down, but it did not even make an attempt to build up." Yet in the department of science what can we mean by "building up" if it be not the organization and analysis of facts, the derivation of principles, and the establishment of a connected body of truths as accurate and verifiable as the nature of the phenomena and the condition of knowledge will admit. Is not this in the highest sense constructive work, and, making allowance for the necessary imperfections of the earlier stages of inquiry, it can not be intelligently denied that the English school of economists have established a body of positive truths which can never be subverted, although they may be much further unfolded. We think, indeed, that Dr. Ely's accusation against the English school may be turned with far greater propriety against the German school, which has made no discoveries, constructed no system, worked out no generalizations, and whose main stock in trade appears to consist in its attempts to demolish what the English economists have built up.

We gather from Dr. Ely's argument that a very confusing and also a most mischievous error pervades the teachings of the new school—it does not discriminate between science and art, between economical principles and laws and the art of practical politics. The investigation of phenomena, the establishment of their relations, and the derivation of principles, is a sufficiently large subject to occupy distinctive attention, and science proper ceases when this important work is done. The results gained will be valuable in application, but this is a separate field of effort. Law-making may be helped by science, but to rank it as itself a part of economic science confuses important distinctions. That the German school should favor paternalism in government, and legislative interference with the business life of the people, should magnify the state, belittle individualism, and question the doctrine of natural human rights, is what we are prepared to expect, but when all this is put forward as political economy, and a warrant for the installation of a "new school" to replace a fallen system, the case seems somewhat strained. It is not so easy to take leave of the older idea of legitimate science in this field of thought. And yet the tendency of government to encroach upon the liberty of citizens, and regulate the private affairs of industry and business, although as old as political tyranny, is now coolly put forth as the discovery of a great master of political economy. Dr. Ely says that "Adolph Wagner, the Coryphæus of German economists," has discovered "the law of increasing functions of government"—"has shown how government has taken upon itself function after function, and how the operations of government trench more and more upon the domain of private industry." If the reader will here refer to what is said upon page 302 of this "Monthly," he will get further light upon the new school claim of what it considers a discovery in the progress of political economy.

Dr. Ely objects to the English school, not only that it is deficient in facts and data, indulges too much in theory and neglects history, but also that it is narrow and ignores the wide range of social phenomena with which it is connected; and he refers to Professor Ingham's address, in which it is maintained that political economy must in future be considered from the point of view of social science, or as a branch of the more comprehensive subject of sociology. But, granting that the old system is more or less open to these objections, do they really stand against the English school of to-day, and has the German school met them in any adequate or systematic way? History is, of course, important; but scholars may dig in history to the end of time to no purpose if they can not reduce their results to organized knowledge. We have the living facts all before us and all around us, open to immediate observation, to be directly studied in their actual relations, and, until the positive and palpable realities of experience are first mastered and reduced to valid method, it is useless to go back into distant ages to study these same phenomena in the vague representations of a history written in utter ignorance of the bare fact of the existence of such a subject as political economy. As well turn the anatomist away from his actual dissections to get help from history by the study of old Arabian treatises, or cutting up Egyptian mummies. History is important; but it is of very subordinate importance, and must be preceded by the scientific investigation of actual facts and laws wherever these are accessible to study. German erudition may add to the rubbish-heaps of chaotic lore regarding the economic life of ancient peoples; but the question remains how German scholars are grappling with the problems of present economic experience. We fail to find evidence that they are making much headway in this direction. Can it be that they have fled to history, "in order to ally themselves with the great reformers in politics, in jurisprudence, and in theology," because of incompetence to deal with this vast subject as it stands in our modern civilization by the strictly scientific method? Whatever view we may take of the extent of the law of evolution, it is at any rate the key of human progress and of social history. Has the historical school recognized it? On the contrary, we must look to England for the thinkers who have made this vast step in the advance of historical method. The monumental work, which complies with all Dr. Ely's requirements, which consists wholly of systematized data and abstains entirely from theory, which considers economical facts in connection with all the other elements of society, which classifies the comprehensive results of investigation with the simple view of drawing scientific conclusions, and which is, moreover, grounded upon the principle of historical development, is an English enterprise—a system of descriptive sociology representing the elements of society in seventy-two communities, past and present, civilized and uncivilized, and treating of civilizations extinct, decayed, and still flourishing. But this valuable contribution to comparative sociology, though prepared with immense labor from his own point of view, and making an epoch in the progress of social science, is not even referred to in Dr. Ely's monograph.

Practical Essays. By Alexander Bain, LL. D. New York: D. Appleton & Co. Pp. 338. Price, $1.50.

Those who are familiar with the intellectual individuality of Professor Bain and the range of his studies will be prepared to form some idea of the scope and character of this volume of essays, which is in great part a reprint of articles first contributed to reviews. But the title of the volume indicates a characteristic which might not readily be inferred from the quality of Professor Bain's previous works, many of which are scientific and speculative, while the papers which make up this book are of an eminently practical kind. There is much novelty and originality in many of the suggestions made, but the topics selected, and their mode of treatment, will be found useful and helpful to a large number of readers. The first two essays, on "Common Errors of the Mind," are especially of this practical character, and derive interest from the thorough psychological preparation of the writer. The next two essays have an educational bearing; the one on "Competitive Examinations," and the other on the "Classical Controversy." The fifth article is of particular practical interest to students as delineating the mode of treating philosophical questions in debating societies. Dr. Bain considers "The University Ideal" in his sixth article; and the seventh, which is perhaps the most interesting of all, is a chapter omitted from the author's "Science of Education," and is mainly devoted to the methods of self-education by means of books. This essay abounds in instructive suggestions. The eighth article is on "Sectarian Creeds and Subscription to Articles."

The subject is English, and is handled without reservation. The concluding paper of the volume is devoted to the procedure of deliberative bodies, and what may be called the economics of business in such associations; and in this country of multitudinous Legislatures, and where the complaint of non-accomplishment of deliberative work is so general, the hints here given will be found important.

James and Lucretia Mott: Life and Letters. Edited by their Granddaughter, Anna Davis Hallowell. With Portraits. Boston: Houghton, Mifflin & Co. Pp. 556. Price, $2.

Aside from the charming interest of this volume as a biographical study, it will be found instructive as a record of social experiences during the last half-century that will be increasingly appreciated in the future. It might properly be called "The Life and Times of Lucretia Mott," because it deals fully with her public influence so as to become a valuable chapter in the history of a peculiar religious denomination, which is closely connected with the great anti-slavery reform that was full of such eventful issues to the country.

The history of the Society of Friends, when it comes to be philosophically written, will be full of instructive interest. That the denomination is declining, is very well known; but it has been a power in the religious and social life of the community, and has unquestionably exerted a liberalizing influence upon the stringent dogmatism of the more orthodox denominations. Mystical, devout, narrow in many things, rejecting religious forms, and yet tenaciously clinging to religious form, the Society of Friends has still been more protestant than the Protestants, and it was in advance of most other sects in working free from the iron dogmas of the old theology. The split that occurred in the society in this country about 1828, in which a large division of the membership organized into an independent society under the leadership of Elias Hicks, was but the result of a growing liberality in the bosom of the denomination. That division, moreover, precipitated the question as to how far it was justifiable for Friends to enter into co-operation with the outside world for philanthropic objects. The society had always been deeply pervaded by the anti-slavery feeling, and had entered its formal protests against the system of African oppression in a much more emphatic way than other religious denominations. There was, therefore, a strong sentiment within the society that drew it into sympathy with the anti-slavery movement which began to take definite and organized shape in the North about 1830. But, notwithstanding the traditional impulses and vigorous tendency of the body to join in the general movement, there grew up an active policy of resistance against new alliances, and a determination to hold the denomination within its old sectarian limits of exclusiveness, under which it preferred to bear its testimonies in its own way. It was in this crisis of the denominational affairs that Lucretia Mott came forward upon the scene, and bore that conspicuous and influential part in bringing the Society of Friends into active participation in the anti-slavery struggle which has made her reputation, and for which she will be remembered in the future.

To all interested in these reminiscences the present volume is peculiarly attractive. Its chief subject must be deemed fortunate in her biographer; for, while the book is a loving tribute to personal excellences, and a vivid and charming delineation of character, it has been written with a clear appreciation of the importance of faithfully representing the circumstances and conditions in which Lucretia Mott accomplished her public work. A large portion of the volume consists of letters which have an historic interest as throwing light upon questions, motives, tendencies, and states of mind of individuals, and of masses, in the stirring and exciting times of the early anti-slavery conflict. Lucretia Mott was first of all, and in her whole nature, a reformer, but she was also from the beginning to the end a Quaker, and that she was a good deal of a politician, or at all events of a tactician, is shown by the shrewd and skillful course by which she succeeded in maintaining her position in the society in a time of revolution, and when there was a strong disposition to disown her, as many other prominent abolitionists were disowned because of their affiliations with non-religious societies. Her liberality of thought in religious matters was an early trait, and is marked throughout her career. She was sympathetic with advanced ideas, and, although neither philosophic nor hardly original in her bent of mind, she had an intuitive sympathy with the pioneers of liberal inquiry, and always spoke of their work with cordial and hearty appreciation. We congratulate the author of the book on the admirable performance of her agreeable task.

Property and Progress, or a Brief Inquiry into Contemporary Social Agitation in England. By W. H. Mallock. New York: G. P. Putnam's Sons. Pp. 248. Price, $1.

Whatever we may think of Mr. Mallock as a philosopher aiming to get at the valuation of life, or as a constructor of social hypotheses, we must grant that at any rate he is a brilliant critic and an effective controversialist. In this volume he overhauls the peculiar socialistic doctrines of Mr. Henry George and Mr. H. M. Hyndman, exposing their fallacies and characterizing their influence with much acuteness of reasoning and equal bluntness of speech. Those interested in these subjects will find the book more than readable. It consists of articles first contributed to the "Quarterly Review," and reprinted without substantial alteration. The writer's aim in the discussion is thus stated: "One of the principal features by which Continental politics have been, during modern times, distinguished from those of England, has, during the last few years, developed itself in England also. I refer to the attempts being now made by extreme radicals on the one hand, and avowed socialists on the other, to identify politics in the minds of the poorer classes with some wholesale seizure, in their behalf, on the property, or on part of the property of the richer; to represent the accomplishment of such a seizure as the main task incumbent on a really popular government, and to madden the people with a conviction that, until the seizure is made, they will be suffering a chronic wrong.

"When we consider the squalor and misery that exist in the heart of our civilization, it is not surprising that language of this kind should sound to many like a new social gospel. The aim of the present volume is to examine, accurately and calmly, into the exact amount of truth underlying this appeal to the sympathies, and to enable the reader to judge whether our contemporary social agitators are men of science, revealing to us new social possibilities, or merely quacks beguiling us with new delusions—whether, in other words, they are the best friends of the people, or whether they are practically their worst and their most insidious enemies."

The Story of the Coup d'État. By M. de Maupas. Translated by Albert D. Vandam. New York: D. Appleton & Co. Pp. 487. Price, $1.75.

The history of the *coup d'état*, the great crime by which Louis Napoleon converted France from a republic into an empire, will ever be of memorable interest, from the character and consequences of the event; but the main interest of the present volume is derived from the fact that it is written by one who was not only himself in the affair, but one of its master-spirits. M. de Maupas was chief of the police in Paris, and as such had control of the operations by which the usurpation of Louis Napoleon was carried out. It may be that there is not much in the volume in the way of revelation, or that was not more or less known before, but it is an important contribution to the historic literature of that period, from its detailed, circumstantial, and systematic account of the transaction.

The Ellipticon; an Exposition of the Earth's Astronomy and the Equation of Time. By J. L. Naish, B. A. Two-page Chart. New York: J. L. Naish, 43 East Twelfth Street.

This chart is an attempt, by means of graphic diagrams and an explanatory text, to make clear the difficult astronomical problem of the equation of time. It contains on one side six representations of the terrestrial and celestial sphere, intended to illustrate the relations of the ecliptic and the equator, motion in the ecliptic and in the equator, and mean and apparent time; and on the other side a section-view of the celestial sphere as regarded from the north pole of the ecliptic—the ellipticon—on which are given the position of the sun, the equation of time, and other elements of the problem, for each day of the year.

History of the Literature of the Scandinavian North. By Frederik W. Horn, Ph. D. Revised by the author, and translated by Rasmus B. Anderson. Chicago: S. C. Griggs & Co. Pp. 500. Price, $3.50.

The inhabitants of Norway, Sweden, Denmark, and Iceland once spoke a common language, and were closely alike in manners and customs. Hence the remnants of their early compositions which have been preserved in writing are treated in this work as forming a single literature. After giving an account of the ancient collections of poems known as the Elder and Younger Edda, the author goes on to trace the development of the Skaldic poetry, and follows this with an account of the Sagas. As the present language of Iceland has varied less from the original tongue than either the Swedish or the Dano-Norwegian, an account of the modern Icelandic literature naturally follows the chapter on the Old Norse. In the second division of the book, the literatures of Denmark and Norway are taken up together; the first two chapters trace their progress through the "Middle Age" and the "Age of the Reformation." Then follows "The Period of Learning" (1560–1700), characterized by the supremacy of the Latin language and of theological learning. The next fifty years are described as the time of Holberg. Of this powerful writer of comedies the author says: "He not only cleared the ground, and winnowed away a vast amount of rubbish which had hindered the development of intellectual life, but, what was of chief importance, the barriers were thrown down which had for centuries separated the people from the learned class, and which the Reformation, with its fresh breath sweeping through the northern lands, had not been able to remove." The period from 1750 to 1800 is called "The Age of Enlightenment," during which appeared Johannes Ewald, whom the author rates as "one of the greatest lyric poets of the North—perhaps even the very greatest." With the present century begins the period of modern Danish literature, whose foremost representative is Oehlenschläger. During this time have appeared also the well-known names, H. C. Andersen, Paluden-Müller, Oersted, Steenstrup, Rask, and Madvig. The literature of Norway since 1814, when that country obtained its independence, is treated in a separate chapter. In Swedish literary history, after the period of the Reformation, came "The Stjernhjelm Period" (1640–1740), which was the time of "Sweden's golden age." Then follow the "Dalin Age" and the "Gustavian Period," bringing the history to 1800. Other Swedish writers of the present century to whom prominence is given are Almquist, Fredrika Bremer, Rydberg, Von Braun, and Runeberg. There is appended to the volume a comprehensive catalogue by Thorwald Solberg, of the Library of Congress, of important books and magazine articles relating to the Scandinavian countries, their language and mythology, which have appeared in English.

Life and Times of the Right Hon. John Bright. By William Robertson, author of "Old and New Rochdale." London, Paris, and New York: Cassell & Co., Limited. Pp. 588. Price, $2.50.

"One anecdote of a man is worth a volume of biography," said Channing; and, in conformity to this dictum, the author's plan has been, "besides resetting gems that adorn Mr. Bright's speeches, to weave into the biography interesting information which is not generally known, and which has been collected especially and solely for this work." The extracts from speeches are numerous, embracing Mr. Bright's utterances on a wide range of subjects, from the temperance question, on which he made his first public speech at the age of nineteen, to the land-troubles in Ireland. The book is a very readable account of the career of one of the most highly esteemed of living statesmen.

The Evidence for Evolution in the History of the Extinct Mammalia. By E. D. Cope, of Philadelphia, Pa. Printed at the Salem Press, Salem, Mass. Pp. 19.

This essay comprises the substance of a paper read before the American Association at its Minneapolis meeting last year. It is a presentment of the subject, made by an author whose extensive acquaintance with the extinct mammalia of our continent—the remains of which he has largely contributed in bringing to light—makes him peculiarly competent to deal with it.

Local Government and Free Schools in South Carolina. By B. James Ramage. Baltimore: Johns Hopkins University. Pp. 40. Price, 40 cents.

This is the twelfth of the valuable series of "Johns Hopkins University Studies in Historical and Political Science." It traces the development of the peculiar political system by which South Carolina was distinguished before the war from the aristocratic plan of the original settlement in the province, under the influence of Locke's "Fundamental Constitutions," as a county palatine, with its lords proprietors, palatines, and its nobility of landgraves and cassiques. This scheme was short-lived, and gave way to the parish organizations in the coast country. Afterward the upper country was settled, and evolved a county system of local government. Then the county system and the parish system clashed, and the district system, which lasted till after the war, was formed for the whole State. This, in turn, was remodeled, and the name "district" was changed to "county" after the war. The second part of the pamphlet is devoted to the history of "Free Schools in South Carolina," with the design of showing that the State had earlier and more liberal provisions for free education than it has been supposed to have had.

Voice, Song, and Speech: A Practical Guide for Singers and Speakers. By Lennox Browne, F. R. C. S. Ed., author of "The Throat and its Diseases," "Medical Hints on the Singing Voice," etc., and Emil Behnke, author of "The Mechanism of the Human Voice," etc. New York: G. P. Putnam's Sons. Pp. 322. Price, $4.50.

This work deals mainly with the physiology and hygiene and the acoustics of the voice. The need of a scientific basis for the production, cultivation, and preservation of the voice is insisted on in the first chapter, and strikingly illustrated by directions given to pupils by some authorities. For instance, "To focus the sound; to direct the voice toward the roof of the mouth—against the hard palate—against the upper front teeth—into the head—to the bottom of the chest; to lean the tone against the eyes! to sing all over the face!" The laws of sound bearing on the voice are next stated, after which the anatomy of the vocal organ is described at length, and the respiratory action is explained. Under vocal hygiene, the proper mode of breathing is described, and cases are given which show the loss of vocal power resulting from a waist deformed by constriction. A chapter on the laryngoscope, its use, and teachings, follows. Voice-culture is taken up under the headings "Breathing, Attack, Resonance, Flexibility, and Registers." Directions are given for the "Daily Life of a Voice-User," and there are chapters on "Ailments of the Voice-User" and "Defects of Speech." As this work is the joint production of a vocal surgeon and a voice-trainer, who have been in the habit of collaborating in the treatment of patients and pupils, the authors believe that it possesses a completeness which is seldom attained by a specialist in a single department. The volume is illustrated with photographs of the larynx and the soft palate in various positions, and with numerous woodcuts.

The Güegüence: a Comedy Ballet in the Nahuatl-Spanish Dialect of Nicaragua. Edited by Daniel G. Brinton, A. M., M. D. Philadelphia: D. G. Brinton. Pp. lii-94. Price, $2.50.

This is the fourth volume of Dr. Brinton's "Library of Aboriginal American Literature." The play which is presented in it is the only specimen of the native American comedy known to the editor. It is of comparatively recent origin, and is composed in a mixed dialect, a jargon of low Spanish and corrupt Aztec, or Nahuatl. It bears marks of its native composition in both its history and spirit, and illustrates the sort of humor popular with the tribes from whom it has been obtained, so that it is of considerable anthropological value. The piece is one of several kinds of *bailes* or dramatic dances common among the Nahuas or Aztecs of Nicaragua, and pictures the devices which an elder of the tribe employed to escape the censure of the *alguacil* before whom he was brought up for discipline. Its chief literary character is a coarse, rollicking humor, and it contains some music of no little merit. The most valuable part of the book is the introduction, in which Dr. Brinton precedes the history and a minute analysis and criticism of the play with accounts of the Nahuas and Mangues of Nicaragua, their "bailes" or dramatic dances, and their musical instruments and music.

The Cinchona-Barks. By Friedrich A. Fluckiger, Ph. D., Professor in the University of Strasburg, and author of "Pharmaceutical Chemistry." Translated by Frederick B. Power, Ph. D., Professor of Pharmacy and Materia Medica in the University of Wisconsin. Philadelphia: P. Blakiston, Son & Co. Pp. 101. Price, $1.50.

This treatise comprises a statement of the botanical position of the cinchonæ, with descriptions of the most important species, an account of cinchona-culture and the collection of the barks, the varieties of bark, their appearance and structure, together with some statistics of the industry. In the section on the quantitative estimation of the alkaloids, the translation has a somewhat more detailed description of the author's method of assay than was given in the original, and a more explicit account of the process of Squibb, as recently improved. The method of De Vrij has been added, and also his process for the determination of crystallizable quinine in the mixed alkaloids. A history of the cinchona-barks follows, and a list of about forty titles in the recent literature of the subject completes the volume. It is illustrated with eight lithographic plates and one woodcut.

Scientific Papers of the Vassar Brothers' Institute, and Transactions of its Scientific Section, 1881–1883. Le Roy C. Cooley, Ph. D., Chairman. Poughkeepsie, N. Y. Pp. 118.

The Vassar Brothers' Institute was organized in the spring of 1881, and the scientific section in June of the same year. The present volume of its Transactions embraces the proceedings of thirteen stated meetings up to April 18, 1883, with the chairman's report of the work of the section, and nine papers on subjects of interest in various fields of science. The objects of the Institute are to pursue such scientific researches as may come within the opportunities of its members, and to found a suitable museum. Its proceedings bear evidences of life and vigor.

The Gospel according to Saint Matthew. Revised Version. Fonetic edishun. St. Louis: publisht bai T. R. Vickroy. Pp. 88. Price, 50 cents.

This phonetic edition of Matthew is commended by its editor to those who have occasion to teach adults to read. The value for this purpose of print in which the use of letters is logical and uniform is attested by the superior readiness with which the reading of English has been taught in "Freedmen's schools," and is being taught to-day in certain schools of France from books in phonetic spelling. Dr. Vickroy explains in an appendix the values of the thirteen new letters which he uses.

The Medical Directory of Philadelphia for 1884. Edited by Samuel B. Hoppin, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 205. Price, $1.50.

This volume contains lists, arranged both alphabetically and by streets, of the physicians, homœopathic physicians, dentists, and druggists, of Philadelphia, with information in regard to the hospitals and other charitable institutions, medical colleges, ambulance service, coroner, and quarantine. It gives also the State regulations in regard to dissection, the registration of medical practitioners, and the registration of births, marriages, and deaths.

Bulletin of the Philosophical Society of Washington. G. K. Gilbert, Secretary. Washington: Judd & Detweiler. Vol. VI. 1883. Pp. 168.

The "Bulletin" is published by the co-operation of the Smithsonian Institution. The present volume contains the minutes of the society for 1883, and the minutes of the mathematical section from its organization to the close of the year. A number of valuable papers are contained in the volume, among which we mention especially only the annual address of the President, J. W. Powell, on "The Three Methods of Evolution."

D. Appleton & Co. will publish shortly a volume by the author of "Conflict in Nature and Life," entitled "Reforms, their Difficulties and Possibilities." The penetrating and judicial spirit exhibited in the author's first work will lead many readers to look to the promised volume with no little expectation.

"The Outlines of Psychology, with Special Reference to the Theory of Education," by James Sully, now in the press of D. Appleton & Co., is the kind of book that has been long wanted by all who are engaged in the business of teaching and desire to master its principles. In the first place, it is an elaborate treatise on the human mind, of independent merit as representing the latest and best work of all schools of psychological inquiry. But of equal importance, and what will be prized as a new and most desirable feature of a work on mental science, is the educational applications that are made throughout in separate text and type, so that, with the explication of mental phenomena, there comes at once the application to the art of education.

One of the most fascinating popular scientific books ever written is Dr. Charles C. Abbott's "Rambles about Home," soon to be issued by D. Appleton & Co. Readers of the early volumes of "The Popular Science Monthly" know how interesting Dr. Abbott's sketches are, and this book will surely impel many to spend their first leisure hours in the country in watching the animal life about them.

Professor John Trowbridge, of Harvard University, has written a text-book for schools, which D. Appleton & Co. have in preparation. It is entitled "The New Physics," and admirably carries out the principles of the new education, in requiring the pupil to become familiar with the properties of matter and the phenomena of force by performing experiments for himself.

A new series of science text-books, each of which is the work of an able specialist, is being brought out by D. Appleton & Co. The "Physiology," by Roger S. Tracy, M. D., Sanitary Inspector of the New York City Health Department, and the "Chemistry," by Professor F. W. Clarke, Chemist of the U. S. Geological Survey, are now ready. Before September 1st will be issued the "Zoölogy," by C. F. Holder, and J. B. Holder, M. D., Curator of Zoölogy of the American Museum of Natural History, New York; and the "Geology," a new elementary book, by Professor Joseph Le Conte, of the University of California. Other volumes are to follow soon.

PUBLICATIONS RECEIVED.

Proceedings, etc., of the Chautauqua Society of History and Natural Science. William W. Henderson, Secretary. Jamestown, N. Y. Pp. 11.

The Glacial Period in the Chautauqua Lake Region. By Hon. Obed Edson. Jamestown, N. Y.: Chautauqua Society of History and Natural Science. Pp. 13.

Massachusetts State Agricultural Experiment Station. Bulletins No. 7, 8, and 9. Insects injurious to the Apple; Fodder and Fodder Analysis; Insects injurious to Farm and Garden Crops. Pp. 12 each.

Exhibition of Education at the World's Industrial and Cotton Centennial Exposition. Preliminary Circular. Washington: Government Printing-Office. Pp. 11.

Transactions of the New York Academy of Sciences. Index to Vol. II. Albert R. Leeds, Corresponding Secretary, Hoboken, N. J. Pp. 13.

Dictionary of the Action of Heat upon Certain Metallic Salts. J. W. Baird and Professor A. B. Prescott. New York: Bermingham & Co. Pp. 68.

Reports of Division of Entomology, U. S. Department of Agriculture. Washington: Government Printing-Office. Pp. 102.

Samuel Adams, the Man of the Town-Meeting. By James K. Hosmer. Baltimore: N. Murray. Pp. 60. Price, 35 cents.

Physiographic Conditions of Minnesota Agriculture. By Professor C. W. Hall. Minneapolis, Minn. Pp. 15.

Zoölogical Society, Philadelphia. Twelfth Annual Reports. Pp. 25, with Plates.

The Bible an Exact Science. By Philip T. West. Topeka, Kansas: George W. Crane & Co. Pp. 56.

Alabama Weather Service, April, 1884. By R. H. Mills, Jr., Director, Auburn. Pp. 6, with Charts.

The Exhalation of Ozone by Flowering Plants. By J. M. Anders, M. D., Ph. D. Pp. 14.

Remarks on the Bag-Worm, pp. 83; Notes on North American Psyllidæ, pp. 12; Canker-Worms, pp. 32; The Army-Worm, pp. 63. By C. V. Riley, Ph. D., Washington.

Principal Characters of American Jurassic Dinosaurs; Parts VII and VIII. Pp. 8 and 12, with Plates. Principal Characters of American Cretaceous Pterodactyls; Part I. Pp. 4, with Plate. A New Order of Extinct Jurassic Reptiles. P. 1. By Professor O. C. Marsh, Yale College, New Haven, Conn.

A New Theology. By the Rev. Philip S. Moxom. Pp. 20.

On the Classification of the Sciences. By H. M. Stanley. London. Pp. 10.

Wages and Trade in Manufacturing Industries in America and in Europe. By J. Schoenhof. New York: G. P. Putnam's Sons. Pp. 25. 15 cents.

Report of Bureau of Statistics, Treasury Department, U. S., October–December, 1883. Washington: Government Printing-Office. Pp. 160.

Geology of the Lead and Zinc Mining District of Cherokee County, Kansas. By Erasmus Haworth. Oskaloosa, Iowa: Herald Printing Co. Pp. 47.

"American Meteorological Journal," May, 1884. Monthly. M. W. Harrington, Editor. Detroit, Mich.: W. H. Burr & Co. Pp. 39. $3 a year.

Fire-Proof Buildings with Wooden Beams and Girders and Dolman's Dampers. New York: William H. Dolman. Pp. 18.

On a Carboniferous Ammonite from Texas. By Professor Angelo Heilprin, Philadelphia. Pp. 3.

"Home Science," May, 1884. Monthly. New York: Selden R. Hopkins. Pp. 112. $2.50 a year.

Report on the Cotton Production of Georgia. By R. H. Loughridge, Ph. D., Berkeley, Cal. Pp. 184, with Lithological Maps.

Recent Improvements in Astronomical Instruments. By Simon Newcomb. Washington: Government Printing-Office. Pp. 28.

Coefficients for correcting Planetary Elements. Pp. 48. Investigations of Corrections to Greenwich Planetary Observations. Pp. 56. Development of the Perturbative Function. Pp. 200. Washington: Bureau of Navigation, Navy Department.

Peabody Museum of American Archæology and Ethnology. Sixteenth and Seventeenth Annual Reports. Vol. III, Nos. 3 and 4. Cambridge, Mass. Pp. 234.

Archæological Institute of America. Reports 1883-'84. Cambridge: John Wilson & Son. Pp. 118.

Geological History of Lake Lahontan, Nevada. By Israel Cook Russell. Washington: Government Printing-Office. Pp. 40.

Synopsis of the Fishes of North America. (Bulletin U. S. National Museum.) By David S. Jordan and Charles H. Gilbert. Washington: Government Printing-Office. Pp. 1018.

Beiträge zur Kenntniss der Kobalt-, Nickel- und Eisenkiese (Contributions to the Knowledge of Cobalt, Nickel, and Iron Gravels). By Leroy W. McCay, Freiberg, Saxony.

Beiträge zur Anatomie Ancylus fluviatalis (O. F. Müller) and Ancylus lacustris (Geoffroy). (Contributions to the Anatomy of Ancylus, etc.). By Dr. Benjamin Sharp, of Philadelphia. Würzburg, Germany.

Medicinisch-Chirurgisches Correspondenz-Blatt für Deutsch-Americanische Aerzte (Medical and Surgical Correspondence Leaf for German-American Physicians), Monthly. Dr. M. Hartwig, Buffalo, N. Y. Pp. 48. $2.50 a year.

Property and Progress, by W. H. Mallock. New York: G. P. Putnam's Sons. Pp. 248. $1.

Whirlwinds, Cyclones, and Tornadoes. By William Morris Davis. Boston: Lee & Shepard. New York: Charles T. Dillingham. Pp. 90.

The Book of the Beginnings. By R. Heber Newton. New York: G. P. Putnam's Sons. Pp. 311. 40 cents.

Geological Excursions. By Alexander Winchell, LL. D. Chicago: S. C. Griggs & Co. Pp. 234. $1.50.

Warren Colburn's First Lessons (in Arithmetic). Boston: Houghton, Mifflin & Co. Pp. 216. 35 cents.

Lecture Notes on General Chemistry. By John T. Stoddard, Ph. D. The New Metals. Northampton, Mass.: Gazette Publishing Company. Pp. 84.

Home and School Training. By Mrs. H. E. G. Avey. Philadelphia: J. B. Lippincott & Co. Pp. 192.

Truths and Untruths of Evolution. By John B. Drury, D. D. New York: Anson D. F. Randolph & Co. Pp. 140. $1.

Lectures on the Science and Art of Education. By Joseph Payne. New York: E. L. Kellogg & Co. Pp. 256. $1.

Fifth Avenue to Alaska. By Edward Pierrepont. New York: G. P. Putnam's Sons. Pp. 329, with Maps. $1.75.

The Bible analyzed in Twenty Lectures. By John R. Kelso. New York: Truth-Seeker Office. Pp. 833. $3.

Government Revenue. By Ellis H. Roberts. Boston: Houghton, Mifflin & Co. Pp. 389. $1.50.

The Franco-American Cookery-Book. By Felix J. Déliée. New York: G. P. Putnam's Sons. Pp. 620. $4.

Key to North American Birds. By Elliott Coues, Ph. D. Boston: Estes & Lauriat. Pp. 863. $10.50.

POPULAR MISCELLANY.

The Coming International Electrical Exhibition.—The Franklin Institute is making arrangements for the most complete representation of electrical appliances at the International Electrical Exhibition, which is to be held under its auspices in Philadelphia, from September 2d to October 11th. A place is provided on its programme for every kind of apparatus and application of electricity, with the items so grouped and arranged as to make prominent the significance and value of each. Much interest is attached to the historical collection of all first and original electrical apparatus, which will form a special department, and which the committee are endeavoring to make as complete as possible. A "Memorial Library" is also to be secured, of all publications in any way pertaining to electrical science up to the date of the exhibition—to include not only books, but also papers, reprints of articles, and notes on or relating to electricity.

Deprived of the Pleasures of Taste.—A writer in the "Cornhill Magazine" says of Harriet Martineau that "she had no sense of taste whatever. 'Once,' she told me with a smile, when I was expressing my pity for this deprivation of hers, 'I tasted a leg of mutton, and it was delicious. I was going out, as it happened, that day, to dine with Mr. Marshall at Coniston, and I am ashamed to say that I looked forward to the pleasures of the table with considerable eagerness; but nothing came of it, the gift was withdrawn as suddenly as it came.' The sense of smell was also denied her, as it was to Wordsworth; in his case, too, curiously enough, it was vouchsafed to him, she told me, upon one occasion only. 'He once smelled a bean-field and thought it heaven.' It has often struck me that this deprivation of those external senses (for she lost her hearing very early) may have had considerable influence in forming Miss Martineau's mental characteristics; but if it turned her attention to studies more or less abstruse, and which are seldom pursued by those of her own sex, it certainly never 'hardened' her."

Communication with Animals.—Sir: You did me the honor, some weeks ago, to insert a letter of mine, containing suggestions as to a method of studying the psychology of animals, and a short account of a beginning I had myself made in that direction.

This letter has elicited various replies and suggestions which you will, perhaps, allow me to answer, and I may also take the opportunity of stating the progress which my dog "Van" has made, although, owing greatly, no doubt, to my frequent absences from home and the little time I can devote to him, this has not been so rapid as, I doubt not, would otherwise have been the case. Perhaps I may just repeat that the essence of my idea was to have various words such as "food," "bone," "water," "out," etc., printed on pieces of card-board, and, after some preliminary training, to give the dog anything for which he asked by bringing a card. I use pieces of card-board about ten inches long and three inches high, placing a number of them on the floor, side by side, so that the dog has several cards to select from, each bearing a different word.

One correspondent has suggested that it would be better to use variously-colored cards. This might, no doubt, render the first steps rather more easy, but, on the other hand, any temporary advantage gained would be at the expense of subsequent difficulty, since the pupil would very likely begin by associating the object with the color, rather than with the letters. He would, therefore, as is too often the case with our own children, have the unnecessary labor of unlearning some of his first lessons. At the same time, the experiment would have an interest as a test of the color-sense in dogs.

Another suggestion has been that, instead of words, pictorial representations should be placed on the cards. This, however, could only be done with material objects, such as "food," "bone," "water," etc., and would not be applicable to such words as "out," "pet me," etc.; nor even as regards the former class do I see that it would present any substantial advantage.

Again, it has been suggested that "Van" is led by scent rather than by sight. He has, no doubt, an excellent nose, but in this case he is certainly guided by the eye. The cards are all handled by us, and must emit very nearly the same odor. I do not, however, rely on this, but have in use a number of cards bearing the same word. When, for instance, he has brought a card with "food" on it, we do not put down the same identical card, but another with the same word; when he has brought that, a third is put down, and so on. For a single meal, therefore, eight or ten cards will have been used, and it seems clear, therefore, that in selecting them "Van" must be guided by the letters.

When I last wrote I had satisfied myself that he had learned to regard the bringing of a card as a request, and that he could distinguish a card with the word "food" on it from a plain one; while I believed that he could distinguish between a card with "food" on it and one with "out" on it.

I have now no doubt that he can distinguish between different words. For instance, when he is hungry he will bring a "food" card time after time until he has had enough, and then he lies down quietly for a nap. Again, when I am going for a walk, and invite him to come, he gladly responds by picking up the "out" card, and running triumphantly with it before me to the front door. In the same way he knows the bone card quite well. As regards water (which I spell phonetically so as not to confuse him unnecessarily), I keep a card always on the floor in my dressing-room, and whenever he is thirsty he goes off there, without any suggestion from me, and brings the card with perfect gravity. At the same time he is fond of a game, and if he is playful or excited will occasionally run about with any card. If, through inadvertence, he brings a card for something he does not want, when the corresponding object is shown him, he seizes the card, takes it back again, and fetches the right one. No one who has seen him look along a row of cards, and select the right one, can, I think, doubt that in bringing a card he feels that he is making a request, and that he can not only perfectly distinguish between one word and another, but also associates the word and the object.

I do not for a moment say that "Van" thus shows more intelligence than has been recorded in the case of other dogs—that is not my point—but it does seem to me that this method of instruction opens out a means by which dogs and other animals may be enabled to communicate with us more satisfactorily than hitherto. I am still continuing my observations, and am now considering the best mode of testing him in very simple arithmetic, but I wish I could induce others to co-operate, for I feel satisfied that the system would well repay more time and attention than I am myself able to give. I am, sir, etc., JOHN LUBBOCK.

HIGH ELMS, HAYES, KENT.

—*London Spectator.*

Gas-Poisoning. — According to statements of Professor Pettenkofer at the recent Hygienic Congress in Berlin, the poisonous property of coal-gas depends upon its containing carbonic oxide in the proportion of about ten per cent, while the other constituents, although irrespirable, do not act as direct poisons. The danger in breathing the gas depends not so much on the duration of the exposure to a mixture of air and carbonic oxide as upon the amount of the latter contained in the air. Air containing only a proportion of five parts of carbonic oxide in 10,000 can be breathed for hours and even days by men and animals without any injury to health; while a proportion of seven or eight in 10,000 causes appreciable discomfort; of twenty in 10,000, difficulty of breathing, weakness, and uncertainty in gait; a proportion of twice that ratio leads to stupefaction, and higher proportions to extreme and fatal effects referable to the nervous system. Illness attributable directly to the entrance of gas into the house from the mains has been found to increase in the winter months, largely, probably because of the closing of the windows and the artificial heating of the rooms by which the gas is attracted into them. Dr. Pettenkofer has cited several striking instances of severe affection and even death that occurred in dwelling-houses in consequence of leakage from street-mains. At Roveredo, two sisters who slept in a basement contracted severe headaches during three successive nights. On the fourth night, which was a very cold one, the mother slept with them. None of the three appeared on the following morning, and on investigation the two sisters were found dead, and the mother so nearly so that she only survived a few days. The escaping gas, under the roadway, was thirty-five feet distant from the room. At Cologne, three persons in one family were killed in a single night in 1871, by a leak ninety-eight feet away. The superintendent of a prison in Breslau died and his sons were afterward found unconscious, in the same room, in 1879, from a leak thirty-five and a half feet away. Another instance has been recorded in Breslau, where the distance of the leak was one hundred and fifteen feet. At Cologne the gas passed through a sewer-channel and through the floor, while in the other cases it traversed layers of earth. The variation in the degree of cold between one night and another, causing corresponding differences in the force by which the gas is attracted to the rooms, would, in Dr. Pettenkofer's opinion, sufficiently account for the difference in the gravity of the effects produced on these occasions. Gas filtered through the soil from the mains may be quite odorless, at least until it has collected in large amount; and herein lies the danger to dwellers in the basement. On the earliest occurrence of such symptoms as headache, the windows should be thrown open; and if, on closing them again, the symptoms reappear, it may be suspected that gas is escaping into the house.

Dr. Crothers's Studies of Inebriety.—Dr. T. D. Crothers, of Hartford, Connecticut, read before the London Branch of the British Medical Temperance Society an historical paper on the study of inebriety in America. A fact of psychological interest pertaining to the subject is, that inebriety in this country moves in waves and currents, with a decided epidemic and endemic influence. This can be traced in the rapid increase of drunkenness in towns and cities, till after a time a reaction sets in, and a marked decline follows. "These waves of inebriate storms that sweep over large circles of country are always followed by intense revivals of temperance interest, and are fields of the most fascinating psychological inquiry yet to be studied." An increase of inebriety among our women is asserted as apparent in the great demand for narcotics, the sale of beer and wine by grocers, and the divisions of saloons by general and family entrances, with separate rooms for each. The vice is considered a pronounced form of brain and nerve degeneration coming from well-marked physical conditions, largely controlled by social and psychical states peculiar to the country. The symptomatology of the disease "more nearly resembles that of insanity and general paralysis; its course is in waves and currents; its progress is shorter; and among women the use of narcotics is more prevalent than that of other forms of alcohol." In estimating the value of remedies, Dr. Crothers believes that all efforts by moral means have failed, and are of value almost exclusively as agitations that will call attention to the evil. Legal means, by coercion and punishment, are likewise inefficacious, although there may be a value in prohibition, to be determined by the experience of the future. In his own view, inebriety being regarded as a disease, like insanity, should be, like insanity, treated as a disease; and the cure should be sought in the enlightened treatment of the inebriate asylums.

How to expose Thermometers.—Dr. H. A. Hazen discusses, in the "American Journal of Science," the conditions of thermometer exposure best adapted to secure uniform accuracy in the indications of temperature. One of the first conditions to be regarded is that of securing a good height above the ground, on which considerable diversity of opinion prevails. Much depends upon the immediate conditions of the locality. When this point is decided upon, a uniform and satisfactory shelter or screen should be provided for the instrument. The height and the screen should be so adjusted that the thermometer shall be free from the influence of ground-fog and that access of the air to it should be perfect. The shelter should shield from all reflected heat, from all direct radiation, from the sun by day, and from the earth to the sky by night, and from all radiation from surrounding objects, as well as from moisture. Many different forms of shelter have been contrived in different countries. In experimenting upon the merits of these devices, a standard of comparison is found in the swung thermometer, or, as the French call it, the *thermomètre fronde*, which is a common thermometer attached to a string or wire, and rapidly swung through a circumference whose radius is the length of the string. The theory of this arrangement is that, as the instrument is rapidly brought in contact with a large mass of air, it must give the temperature of the same unless the results are vitiated by other causes. From a number of experiments described by Mr. Hazen, the following conclusions as to the best dispositions of shelters are advanced: When exposed to direct sun-heat, they should be at least thirty-six inches long; with proper precautions the thermometer "fronde," both dry and wet, will give the most correct air-temperature and relative humidity; a single louvre shelter is sufficient. The interposition of a second louvre prevents the free access of air, and if ventilation is used it must affect the air which is propelled to the thermometer. For obtaining even approximate relative humidity in calm weather, single-louvred shelters are necessary, and for the best result an induced air-current is essential, especially in the winter in northern countries. Where a window shelter is used, there should be a free air-space of from six to twelve inches between the shelter on the north side of the building and the wall. The simplest form of screen would be four pieces of board ten or twelve inches square, nailed together box-fashion, leaving the bottom and the side toward the window open; the thermometers, dry and wet, should be placed five inches apart near the center of this screen, with their bulbs projecting below the plane of the lower edge. Shade may be given, at such times as the sun is shining on the north side of the house, by the adjustment of the window-blinds.

Numismatics in the United States.—From a paper read by Mr. W. Lee before the Philosophical Society of Washington, we learn that an extended interest in numismatics began to show itself in this country in 1858, at which time there were probably not as many as a hundred coin-collectors in the United States. The interest has grown rapidly, until now there must be on the books of the United States Mint the names of at least one thousand collectors who receive yearly the issue of the mint, with special proof-polish. In New York, alone, during the year 1882, thirty-nine collections were sold at public auction, and brought, in all, $68,441.36. Several of our large cities have numismatic societies, some of which are designated as numismatic and archæological societies; and a number of periodicals devoted simply to the interest of numismatics obtain a satisfactory circulation.

Seasonal Variations of Rheumatism.—The records of rheumatic cases in the London Hospital fail to show any clear relation between the prevalence of the disease and particular climatic conditions. Dr. Henry S. Gabbett has compared the graphic curves representing the numbers of cases observed for nine years, and remarks a general similarity between them. In nearly every case a wave is noticed beginning to rise at the opening of summer, and reaching its highest elevation in July or August; then comes a temporary check or fall, followed by a rapid ascent till the summit is reached, at the end of autumn, when a steady fall occurs through the months of December, January, and February, till a low level is reached, which continues nearly even till about the beginning of the next summer elevation. The curves for different years do not appear to be affected by variations in the character of the seasons from which it is possible to make any deduction respecting the influence of variations of temperature or of conditions of moisture. Accepting Messrs. Buchan and Mitchell's division of the London year into six periods, each having a climate peculiar to itself, "we find that rheumatism was most prevalent in the annual damp and cold period; next in the damp and warm period; cases were about equally frequent in the two periods characterized respectively by heat and cold; below these comes the dry and warm period; and lowest of all, as regards the frequency of the disease, the period described as dry and cold. . . . It does not, however, necessarily follow that there is any etiological connection between the above facts; the periodical prevalence of the disease may possibly be independent of conditions of climate." Dr. Gabbett draws the conclusions, with a little more confidence, that the disease is neither most prevalent in the coldest months of the year, nor least prevalent in the warmest; that it does not occur with greatest frequency in those months in which the daily variations of temperature are greatest; that, although there is a certain correspondence between the rainy periods and the times when rheumatism is common, it is not close enough to point to any necessary connection. But cases of the disease are very numerous at that period of the year during which there is usually a coexistence of low temperature and heavy rainfall—viz., the end of autumn.

Shall we put Spectacles on Children?—In a paper with this title Professor Julian J. Chisholm, M. D., of the University of Maryland, makes a plea for providing children with the means of counteracting their congenital or acquired defects of vision. According to the traditions, the need of spectacles is an indication of old age, and so the world interprets it. A better knowledge, however, is diffusing itself among the medical profession, and from them to the public. While advancing years may be a factor, it is only one of many causes inducing defective vision. The action of the perfect eye conforms to the law of optics that, unless a lens focuses accurately on the recipient surface, the image made must be more or less imperfect. In front of the lens there is a broad, circular ligament of the eye, which presses against it, and, when objects at a short distance are to be looked at, by the action of a muscle (the ciliary), the compressing ligament is relaxed, so that the lens, its natural elasticity responding at once to the relief, becomes more convex, and is, therefore, in condition to focus more powerfully light coming from near objects. What is called accommodation, or ability to change the focus, is, then, a muscular act. When the accommodating muscles are temporarily enfeebled by diseased conditions of the system at large, they do not lift off sufficiently the flattening band, or they are too weak to keep up the continued action for the relief of lens pressure; hence we often find children recently recovered from an attack of measles, scarlet fever, diphtheria, whooping-cough, or from any one of the depressing diseases of childhood, unable to study as they did before the attack. A weak-magnifying spectacle, by helping the muscles to do their work, will enable such children to continue their studies till tonics daily administered restore the needful strength to the enfeebled muscles. The foregoing statements are based upon perfect eyes. Unfortunately, the eyeball, with the many other features, has not always the perfection of symmetry. Near-sighted long eyes and over-sighted flat eyes are the common deviations from the standard shape. In the near-sighted eye, called *myopic*, the eye is so long from front to back that the lens is too far from the retina. The result is, that rays of light from a distant object come to a focus, and have begun to diverge when they reach the retina, so that the image formed is blurred. The second deviation in the form of the eye is called *hyperopia*. This is a flat eye, a very common form in children. It is a congenital defect, in which the crystalline lens is located so near the retina that light, passing into the eye, is stopped by the retina before it comes to a focus. This must also produce an ill-defined picture. Unfortunately, faulty eyes, which give out under use, do not appear differently from perfectly shaped ones. The flattening, or the elongation, is not in the exposed cornea. It is usually at the expense of the inner half of the eyeball, hid away in the socket. If children, either by inheritance or acquisition, have misshaped eyes, so that they can not see objects clearly through the usual range of distances, what can be the propriety of allowing them to go through life as if in a constant fog, when a properly selected glass clears up the mist, and enables them to see as others do?

Fresh-Water Pearls.—The cultivation of the pearls of fresh-water mussels has become an industry of considerable importance in Saxony and other parts of Germany. The pearls are generally inferior to those of the genuine pearl-oysters, but occasionally a gem of real excellence is produced. Some very fine settings of such were exhibited at the Exposition in Berlin. The Venetians carried on this branch of trade to a considerable extent during the middle ages, and controlled it till 1621, when the Elector of Saxony also undertook it, at the suggestion of Moritz Schmirler, a draper of Oelsnitz, and appointed Schmirler "first pearl-fisher." Schmirler was succeeded on his death by his son, and the business has continued in the family to the present day, under the superintendency of the forestry department, which has also to do with the waters of the region. The pearl-hunting is carried on in the spring, as soon as the water is warm enough to wade in for hours continuously. The mussels are examined by means of an instrument, by which the shells can be opened enough to see what is within them without hurting the mollusks. If they contain well-developed pearls, they are sacrificed; if not, they are returned to the beds. The same beds are not usually gone over again for several years. Experiments made in the Elster, in the artificial production of pearls, have not met with much success. A wound in the mouth of the mollusk will lead to the deposition of the calcareous matter, but it is uncertain whether it will be of common shell-matter or of pearl—and upon this all the value of the operation depends. In the Dutch East Indies, the formation of pearls in the pearl-oyster is sometimes provoked by inserting a grain of sand within the shell. A considerable business is done at Adorf in the manufacture of articles of fancy from the nacre of mussels.

Geological Survey of Palestine.—Professor Hull has just made a successful geological survey of Palestine, preparatory to the construction of a geological map of the country. He has traced the ancient margin of the Gulfs of Suez and Akabah to a height of two hundred feet above their present level, so as to show that the country has been submerged to that extent and has been gradually rising; and he believes that at the time of the Exodus a continuous connection existed between the Red Sea and the Mediterranean. The Dead Sea appears to have formerly stood at a height of fourteen hundred feet above its present level, or about one hundred and fifty feet above the level of the Mediterranean. Evidences of a chain of ancient lakes have been found in the Sinaitic district, and of another chain in the center of the Wady Arabah, not far from the water-shed. The great line of fracture of the Wady Arabah and the Jordan Valley has been traced to a distance of more than one hundred miles, and the materials for working out a complete theory of this remarkable depression are now available. The terraces of the Jordan have been examined. The relation of these terraces to the surrounding hills and valleys shows that they had already been formed before the water reached their former level; sections have been carried east and west across the Akabah and the Jordan Valley, and two traverses of Palestine have been made from the Mediterranean to the Jordan.

Change as a Recreative Agent. — Sir James Paget spoke, in a recent address, at the Workingmen's College, London, on the value of change as a mental restorative, and found it to consist principally in directing the patient to some form of "work" for which he has inherited a special capacity. The effect is produced through the awakening and gratification of some dormant love or propensity which lies deep down in the individual nature and has been inherited. It thus appears that the special pleasures of individual lives are ancestral, or are "survivals in us of instincts that belonged to our distant ancestors, who of necessity had to kill, to fish, to hunt, to clear the forests, and make the roads." The mere recommendation of "change" vaguely is idle; but recreative change, judiciously recommended and specifically applied, is one of the most powerful agents we possess for the treatment of disease, or of derangements and disturbances of the mental temperament and the mind.

NOTES.

The thirteenth series of Professor C. G. Rockwood's "Notes on American Earthquakes," in the "American Journal of Science," includes seventy-eight notices of shocks that occurred on the American Continents during 1883. Of these, eight were in Canada, three in New England, two in the Atlantic States, eleven in the Mississippi Valley, and twenty-three on the Pacific coast, while the rest were in Mexico, the West Indies, and Central and South America. The more important shocks were recorded —January 11th, Cairo, Illinois; March 8th, Panama; May 19th, Ecuador; August, Mexico; and October 6th, Alaska. Most of the shocks were very moderate, and caused little or no damage.

Dr. Ernst Behm, a German geographer, died March 15th. He had been for twenty-eight years editorially connected with the "Geographische Mittheilungen" of Justus Perthes in Gotha. He was joint editor of Behm and Wagner's celebrated statistical publication.

The Trustees of the University of Pennsylvania have elected Dr. Joseph Leidy, Director, and Professor of Anatomy and Zoölogy, of the new Biological Department. Dr. J. T. Rothrock has been elected Professor of Botany; Dr. A. J. Parker, Professor of Comparative Anatomy; Dr. Benjamin Sharpe, Professor of Invertebrate Morphology; Dr. Horace Jayne, Professor of Vertebrate Morphology; and Dr. Harrison Allen, Professor of Physiology. Women are to be admitted as students.

The whole history of the once famous book, the "Vestiges of Creation," is told by Mr. Alexander Ireland, in the twelfth edition, just published. In agreement with what the world has long understood, the author is at last declared on the title-page to have been Mr. Robert Chambers. According to Mr. Ireland's account, Mr. Chambers employed his wife as his amanuensis in writing the book, and Mr. Ireland as the medium of communication with his publishers. Only four persons were at first in the secret of the authorship, of whom Mr. Ireland is the sole survivor.

Experiments by Messrs. R. Pictet and E. Yung have resulted in showing that some of the microbes at least can sustain a temperature of $-70°$ to $-130°$ C. ($-94°$ to $-200°$ Fahr.) for periods of several hours, and still live and thrive on the accession of more favorable temperatures.

It is suggested that papers will be acceptable to be read before the Anthropological Section of the British Association on American subjects, as follow: "The Native Races of America, their Physical Characters and Origin"; "Civilization of America before the Time of Columbus, with Particular Reference to Earlier Intercourse with the Old World"; "Archæology of North America, Ancient Mounds and Earth-Works, Cliff-Dwellings and Village-Houses, Stone Architecture of Mexico and Central America," etc.; "Native Languages of America"; and "European Colonization and its Effects on the Native Tribes of America." Papers should be sent in to the office of the Association, 22 Albemarle Street, London, W., on or before July 1st.

Dr. Robert Angus Smith, Inspector-General of Alkali-Works for the United Kingdom, died May 12th, aged sixty-seven years. He was the author of a "Life of Dalton," of a work on "Air and Rain," and of papers in the "Philosophical Transactions, the "Journal of the Philosophical Society," and the "Journal of the Society of Arts."

Mr. W. F. Hillebrand describes, in the "American Journal of Science," what he regards as a new mineral which he has found in connection with the sulpho-bismuthite of copper and silver. It occurs in the form of small, slender crystals, in cavities of the bluish-gray sulpho-bismuthite, which are generally bronzed by oxidation, and so deeply striated as sometimes to present the appearance under the glass of bunches of needles. Their habit is strikingly like that of bismuthinite, for which the crystals were at first taken. Analyses and the examination of their properties mark them as probably of a pure sulpho-bismuthite of copper, in the more compact portions of which silver may replace a part of the copper, while in some cases a further replacement of copper by lead takes place. No name is as yet proposed for the mineral.

At a recent meeting of the Sociological Section of the Birmingham Natural History Society, it was decided to begin immediately the preparation of an index to the study of sociology. Letters were read from Mr. Spencer, approving the system which the section proposes to adopt, and saying that time and the condition of his health alone had prevented his beginning a similar work.

M. Charles Adolph Würtz, the distinguished French chemist, whose name is particularly associated with the progress of organic chemistry during the last half-century, died very suddenly on the 12th of May last. A portrait and a sketch of M. Würtz were published in "The Popular Science Monthly" for November, 1882.

The American frigate Pensacola, passing on the 22d of December last by the Strait of Sunda, crossed large fields of pumice-stone, and continued to observe small quantities of such matter till the 10th of January, when it was in latitude 16° 7′ south, and longitude 66·8° east. The pumice was not seen every day, but few days passed without observing some; and those cakes that were seen after the 1st of January were covered with shells and plants, while some held little crabs in their pores. These pumices were derived either from the May or the August eruption of Krakatoa.

M. L. Cruls, describing, in a note to the French Academy of Sciences, the "red sunsets" as seen in Brazil, states that at first the setting of the sun was preceded by a gradual darkening caused by the interposition between the eye of the observer and the sun of a bed of absorbing vapors, having a smoky aspect, like that of "dry fog." At a later period the glow corresponded closely in appearance with the phenomenon as described in Europe. M. Cruls is of the opinion that the glow is of the same character as the twilight phenomena described in the "*Espace céleste*" of M. Emm. Lias, which, though possibly having a meteoric origin, partook of the character of atmospheric twilight.

Signor Quintino Sella, President of the Accademia dei Lyncei of Rome, died on the 14th of March. He was distinguished for valuable researches and papers of great excellence in crystallographic mineralogy, and for his active interest in the geological survey and the preparation of the geologic map of Italy. He was President of the International Geological Congress at Bologna, in 1881. To scientific eminence he added ability as a statesman; and he was for many years Minister of Finance in Italy. Men of science are invited to contribute to the placing of a bronze wreath on his tomb.

Professor Dana believes that the extraordinary rise in the Ohio River, in February last, was the result of the falling of heavy rains at a time when the ground was so solidly frozen as to be wholly destitute of the power of absorption. Compared with this, the extent of the forest region had very little to do with the height the river attained; and the same conditions of frost and heavy rain prevailing, the result would not have been materially different had the primitive forest been standing.

It is reported that a cocoanut plantation has been started on the southern coast of Florida. One hundred thousand plants have been set out on a tract of about one thousand acres, at a cost of nearly $40,000, and next winter the number is to be increased. It requires six years for the trees to begin to yield returns, but it is estimated that in ten years the grove will pay ten per cent on a valuation of $2,000,000. A full-grown tree will mature about sixty nuts annually. The Florida cocoanut-culture is limited, however, as it is confined exclusively to the sea-coast, and the trees can be grown only to a small extent in southern Florida.

Professor H. Schlegel, Director of the Royal Museum of Natural History at Leyden, died in January last. Dr. Schlegel was born in Altenburg, Saxony, in 1804, and was appointed Director of the Museum in 1858. Under his superintendence, this institution became one of the richest of the kind in existence. Dr. Schlegel was a high authority in descriptive zoölogy, especially in the department of the vertebrata.

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HICKORY-NUTS AND BUTTERNUTS.

By GRANT ALLEN.

THE tall choke-cherry tree in the corner of the meadow, near the hickory clump, is a favorite resort of all the fruit-eating birds in the township for half a mile around in every direction. To the judicious human palate, indeed, the flavor of choke-cherries is not exactly alluring or attractive; they have a disagreeable astringent tinge about their pulp that rather reminds one of alum or borax, and they are not sweet enough or luscious enough to be worth eating by people who have grapes and plums and peaches and apples and a dozen other cultivated fruits at easy command. But to the unsophisticated native birds it is quite clear that choke-cherries are rather a dainty and toothsome delicacy than otherwise; and one has only to look at the pretty berries in order to see that they deliberately lay themselves out to attract the favorable attention of these winged allies and visitors. The color of the choke-cherry shows at once that it wishes specially to challenge and allure the notice of the passer-by; its sweet pulp and nutritive qualities show that it means them to eat it, and so aid in dispersing its seed. For the actual, final end of the choke-cherry itself, of course, lies in the stone and its inclosed kernel; all the rest is merely the attractive covering which the plant gives in, as it were, to any friendly bird which will be kind enough to assist it in planting out its young seedlings under favorable circumstances for their future welfare. From time immemorial, those choke-cherries which best succeeded in enticing birds to swallow them, and ultimately to scatter their seeds, protected from injury by the hard and horny covering, have left the largest number of offspring to represent them, and so have survived most frequently, in the person of their descendants, through the midst of that perpetual battling competition for the surface of the earth which goes on as fiercely between trees and plants as between men themselves or other animals. To put it briefly in a single phrase, we may say at once that a choke-cherry is one of the kind of fruits which want to be eaten, and sedulously lay themselves out beforehand for that very particular purpose.

But, when we turn from the choke-cherry to the hickory-trees which grow close by, we are brought face to face at once with another and very different state of things. If the choke-cherry wants to be eaten, the hickory-nut clearly wants to avoid that unpleasant and destructive predicament. In the first place, its color, instead of being brilliant and attractive, like that of most edible fruits, is very quiet and unobtrusive, being green while the nut still remains among the fresh foliage upon the branches of the tree, and pale brown when it falls upon the dead leaves and dry grasses that cover the damp and moldering ground beneath. If the hickory-nut were a conscious creature which deliberately wished to escape notice, these are the precise tactics which it would be likely to adopt for the sake of protection. Then, again, even when its disguise is pierced, and the nut, with its outer husk entire, is spied upon the ground by some hungry animal, it is coated with a very nasty, bitter covering, which effectually repels one from tearing it open readily with the teeth. We hand-wearing human beings, however, may perhaps manage to peel off the outer husk with a knife or stone, or, by more popular practice, to put a lot of the nuts together in a wheat-sack and thrash them out by stamping on them with our feet. Even so, however, we still have the actual woody inner nut-shell itself to deal with; and unless we have arrived at that highest stage of civilization where nut-crackers are specially manufactured for us, to aid us in the struggle, we must crack them as best we may with our own precious and too unstable molars. But the native enemies of the hickory-nut—squirrels and the like—can not proceed in any such crunching and radically destructive fashion. They must bore a hole through the shell somewhere, and then extract the kernel little by little with their long, sharp, curved front teeth; and, somehow, the arrangement of the nut inside the shell is of such sort as to render this work of gradual excavation as difficult as possible for the aggressive rodent. The kernel, instead of being all plain and straightforward, as in the acorn or the chestnut, is divided up and frittered away in little troublesome cricks and corners which seem as if they had been invented on purpose to prevent you from getting a single good bite out of the nut in any part whatsoever. Clearly, the hickory-nut is in all these respects the exact antipodes of the choke-cherry: it doesn't want to get eaten if it can by any means possibly help it.

This glimpse at the habits and manners of the hickory enables us to give a brief and intelligible answer to the question, What is a nut? The reply is, a fruit that tries by inconspicuous coloring and hard coverings to escape being observed and eaten. The reason for such a disposition on the part of the nut is easy enough to understand. In the true or succulent fruits—fruits, that is to say, according to the popular and strictly practical sense of the word—the part we eat is not the actual seed itself, the cherry-stone or plum-stone or raspberry-kernels (which even if we swallow we do not digest), but a soft, pulpy covering which has nothing essential to do with the young embryo or future plantlet. In nuts, on the other hand, the part we eat is the actual kernel or embryo itself, with all the starches, oils, and other food-stuffs laid up for its use by the mother-plant. In the simplest and earliest form of seeds, like those of mustard and cress, for example, there is hardly any store of nutriment put away by the mother for the benefit of its struggling seedling. These poorly endowed plantlets have to open their green leaves to the sunlight the moment they begin to sprout, and, unless they can assimilate fresh food from the air immediately under that genial influence, they must die forthwith of pure inanition. But at a very early period in the evolutionary history of plants, some seeds began to be stored at the outset with small quantities of starch or oil, which enabled their budding embryos to push their heads higher above the surrounding vegetation without depending entirely for support on the mere hand-to-mouth system of daily gains. They had, so to speak, a small reserve of capital to live upon. Of course, this gave all such plants a great advantage over their neighbors in the struggle for existence: they could live under conditions where poorer seedlings would starve and die; and so, from generation to generation, those kinds which laid by most material survived the best on the average, till at last in many cases the embryo came to be very richly endowed indeed with starches, oils, gluten, and other valuable collected food-stuffs. This is especially the case with such seeds as wheat, barley, rye, oats, Indian corn, rice, peas, beans, lentils, and buckwheat.

Unfortunately for the plants, however, what will feed a seedling will feed an animal just as well: and so, exactly in proportion as the plants began to lay by food-stuffs for their own purposes in their embryos, did the animals begin to prey feloniously upon these convenient reservoirs of nutritious gums and starches. Not only does man eat the cereals and pulses, which are the richest in nutriment of almost all seeds, but many earlier and lower animals, such as harvest-mice, rats, chipmunks, deer, antelopes, horses, cow-kind, and even prairie-dogs commit great depredations upon them, both in the wild and cultivated states. Still more particularly have large numbers of animals, such as the squirrels, dormice, monkeys, parrots, nut-hatches, and even many grubs, taken to feeding off the fruits and seeds of forest-trees or woodland bushes. As a consequence, only those richly-stored seeds have for the most part survived which possessed some natural means of defense against their aggressive enemies; and in many instances these means of defense have been multiplied over and over again for still greater precaution, so that the final outcome is a seed almost absolutely fortified against the onslaught of every possible aggressor.

In England, where there are only three native nut-eaters of any importance—the squirrel, the dormouse, and the nut-hatch—most of our indigenous trees have not found it necessary to arm themselves to any large extent against this class of depredators; and consequently there are only three kinds of nuts in the truly aboriginal English flora, namely, the beechnut, the acorn, and the filbert. Chestnuts, walnuts, and horse-chestnuts are cultivated in the British Isles to some slight extent, but they do not thrive, and the two former seldom produce fertile nuts. These three native English kinds, therefore, may be taken as good examples of very simple and undeveloped forms of nuts, far inferior to the most advanced American specimens. The acorn, in all countries, is comparatively little armed with protective coverings: it has only a thin shell, and is guarded from depredations mainly by its slightly bitter taste, as well as by its cup, or saucer, which acts as a barrier against the attacks of insects who try to lay their eggs at its tender base. Beechnuts have a rather more leathery shell, and are externally protected by their prickly husk, which makes them difficult for the delicate noses of squirrels to tackle as they grow upon their native boughs. Filberts, specially exposed to the attacks of the cunning dormouse and the persistent nut-hatch, are far more effectually guarded by a double coat-of-mail: their shell is solid and woody in texture, while their outer husk, which completely envelops them from stem to tip, is thickly sprinkled with stiff and annoying hairs, very painful to our human fingers, and still more so, no doubt, to the tender skin on the naked noses of the inquiring rodents.

None of these nuts belong to the same family as the hickory; they are all independent modifications of totally different forms, which have simultaneously hit on somewhat the same protective method. But on the Continent of Europe, where a larger number of nut-devouring animals are to be found, the hickory tribe is represented by the common walnut. Everybody must have noticed (in conducting his biological studies at dessert) that the distribution of the two lobes which make up the kernel in the walnut is extremely like that of the hickory; and the resemblance is equally close in all other important structural matters. The walnut shows decidedly more protective care in its coverings than any of the few and simple English nuts. Its outer husk is very bitter and nasty—so nasty that even a little of the flavoring matter off fresh walnuts clinging to one's fingers is enough to give a very unpleasant taste to any food one may touch afterward; and the inner shell, though evidently rendered easier to open for the lazy human consumers by being previously kiln-dried to preserve the kernel from decomposing, is in its native state extremely hard to crack, and still harder to bore a hole through with teeth or bill, as any one may easily convince himself by trying to perform the feat with his own canines, or even with the point of his sharp pocket-knife. The walnut, in fact, is one of the hickory tribe, left behind in Europe and Western Asia; it ranges through Greece and Asia Minor, Lebanon and Persia, as far east as Cashmere; and never compelled by circumstances to acquire the very hard and stony coats of some among its American cousins.

In the New World, however, the walnut family has been driven by its pressing animal foes to adopt far more vigorous and active defensive tactics. The great American forests are the very paradise of endless hungry nut-eaters, from the common gray squirrel, the flying-squirrels, and the numerous other greedy rodents of the Northern plains, to the screaming parrots and powerful-billed monkeys of the tropical South American jungles. Where enemies are so numerous and so persistent, only the very hardest and best-protected nuts of all can survive; and so the nearest American representative of the European walnut is the butternut of Canada and the Northern States—a far more formidable and uncompromising mouthful to tackle than its easy-going Old World cousin. The outer husk of the butternut resembles pretty well that of the walnut; but its very stony shell is extremely difficult either to pierce or crack; the sharp ridges on its surface are naturally very baffling to the teeth of squirrels; and even when you have at last made a good hole in it, the inside can hardly be extracted in pieces of any bigness, because of the horny intervening ridges. This American walnut, in fact, is a far 'cuter and smarter form of seed-vessel than its effete European relative. There is every reason to believe, indeed, that the butternut is an advanced and improved descendant of the same primitive geological ancestor as the Greek walnut. Only, while the walnut has been standing still in peninsular Greece and Anatolia for innumerable generations, the butternut has been going ahead with true American impetuosity, inventing one new improvement or modification after another, till it has now attained to almost absolute perfection in its adaptation to its own peculiar walk in life.

Most of the American walnut kind, however, it must be candidly confessed, have not proceeded along the path of progress quite so quickly or so fully as the go-ahead and truly Yankee butternut. The majority of the best-known forms, such as the hickory, the bitter-nut, and pecan-nut, belong to the specially American group known as *Caryas*, with fruits usually smaller and less rich than the regular European walnuts. Even among this restricted group, however, there are some very instructive and interesting differences. For example, the true hickory-nut has a sweet and pleasant kernel, which makes it a great favorite with squirrels and boys. To protect itself against aggression, therefore, on the part of its four-footed foes—as to the boys, it probably despairs—it has acquired a comparatively hard and woody shell, surrounded by a bitter and acrid husk. But its ally, the bitter-nut, has hit accidentally upon a still more excellent and cunning device: it has made the actual seed itself, the menaced kernel, a reservoir for its disagreeable bitter juice. Consequently, it needs much less external protection than the hickory, and every American boy knows well that its shell can be much more readily and easily broken than that of its sweeter relations. Why hickory-nuts should be less protected than butternuts, on the other hand, is a more difficult question; I incline to believe it is because of the greater number produced by each tree annually, so that, in spite of all the havoc wrought by squirrels and other depredators, enough must always have remained and sprouted to keep up the full normal number of the species from one generation to another.

Almost all nuts follow more or less one of these two protective types—the type of the hickory and the type of the bitter-nut—or even sometimes both together. In the tropics, where forestine animals are most developed, the nuts often reach a very high stage of evolution. The cocoanut is a familiar example: it has a soft outer husk, stringy and loose, which breaks and deadens its fall from the tall and graceful palm-trees on which it grows; and inside this yielding, protective mat-work, it has a very solid shell, inclosing the large and richly-stored kernel. But the cashew-nut is, perhaps, the most remarkable in some respects of any known example. It has taken most extraordinary pains to preserve its kernel from injury; and it has done so by a curious combination of the tactics peculiar to attractive fruits with those peculiar to repellent nuts. Its stalk swells out into a fleshy edible tuber, something like a pear in shape, and endowed with all the usual allurements of bright color and sweet taste. By this bribe, it entices the South American monkeys to pick and aid in dispersing its seed. But, at the same time, it carefully wraps up the nut itself in an acrid, pungent covering, and places it at the outer end of the pear-like stalk. Woe betide the adventurous monkey who tries to eat the inner kernel of this decidedly well-protected nut! The pungent juice of the rind not only burns his tongue and lips, but even removes the skin from his mischievous fingers as effectually as it could be removed by a cantharides-plaster. Hardly less quaint are the tactics adopted by the familiar pea-nut of our childhood, which is really the underground pod of a bean-like plant. This secretive vegetable has hit upon the device of producing its seeds on subterranean branches, and so escaping the notice of most open-air birds and mammals; though, in thus cunningly avoiding the Scylla of the upper earth, it has merely fallen against the Charybdis of grubbing pigs and burrowing rodents. The little English subterranean clover—I forget just now whether it grows in America, too, and Dr. Asa Gray's magnificent work is not at hand—has an even stranger plan for escaping from the sheep, on whose favorite pastures it grows abundantly. It flowers above-ground, enticing the bees to fertilize its long, white, tubular blossoms by a copious store of pure and fragrant honey; but as soon as its wee pods have been fairly impregnated with pollen from a neighboring head, it screws its stalk down spirally into the ground, by the aid of some queer little corkscrew gimlets developed near the tip, and so buries the precious seeds well out of all danger from the close-nibbling teeth of its dreaded foes upon the sheep-walk.

Last of all, a few words must be said about the structural homologies of the hickory-nut. In principle, most fruits consist of three separate coats or layers, inclosing the seed or seeds. These three layers are very well seen in the peach, which consists, first, of an external skin; next, of a fleshy edible portion; and, finally, a hard inner covering—the stone—which contains the actual seed, or, as we oftener call it in practical language, the kernel. Now, in the hickory-nut, these three layers are still preserved, though in a very different apparent form: the outer surface, or membrane of the rind, answers to the skin of the peach; the bitter and stringy interior of the rind answers to the edible part of the peach; the nut-shell, or inner hard layer, answers to the stone of the peach; and the nut, or actual seed, answers to the kernel of the peach. This example shows very well by what slight changes in the development of various parts a fruit may seem to practical human eyes quite unlike some other one, which is, nevertheless, at bottom, layer for layer, absolutely identical with it. The only important difference, after all, between the peach and the hickory-nut is, that in the fruit the middle layer becomes soft, sweet, and succulent; while in the nut it becomes stringy, bitter, and nauseating. The almond even better enforces this simple evolutionary lesson; for it is, in reality, nothing more or less than a very dry and stringy peach—a very slightly divergent descendant of the same ancestor: its outermost layer answers exactly to the peach-skin; its tough, fibrous rind is the altered analogue of the flesh in the peach; and its nut (which part alone, shelled or unshelled, we generally see at table) is the equivalent of the peach-stone. But if you cut open a young walnut, a young hickory-nut, a young almond, a young peach, and a young plum, you will be surprised to find how exactly they answer to one another, part for part, and how entirely the conspicuous adaptive differences in the mature nuts or fruits are due to small varieties of development in the very latest stages of the ripening process. Pour a little sweet juice into the middle coat of the almond, and it would be a peach; add a little woody material to the cell-walls of the flesh in the peach, and it would be a very decent almond indeed.

THE GHOST OF RELIGION.

By FREDERIC HARRISON.

IN the January number of this Review* is to be found an article on Religion which has justly awakened a profound and sustained interest. The creed of Agnosticism was there formulated anew by the acknowledged head of the evolution philosophy, with a definiteness such as perhaps it never wore before. To my mind there is nothing in the whole range of modern religious discussion more cogent and more suggestive than the array of conclusions the final outcome of which is marshaled in those twelve pages. It is the last word of the Agnostic philosophy in its long controversy with Theology. That word is decisive, and it is hard to conceive how Theology can rally for another bout from such a *sorites* of dilemma as is there presented. My own humble purpose is not to criticise this paper, but to point its practical moral, and, if I may, to add to it a rider of my own. As a summary of philosophical conclusions on the theological problem, it seems to me frankly unanswerable. Speaking generally, I shall now dispute no part of it but one word, and that is the title. It is entitled "Religion." To me it is rather the ghost of religion. Religion as a living force lies in a different sphere.

The essay, which is packed with thought to a degree unusual even with Mr. Herbert Spencer, contains evidently three parts. The first (pp. 1–5) deals with the historical Evolution of Religion, of which Mr. Spencer traces the germs in the primitive belief in ghosts. The second (pp. 6–8) arrays the moral and intellectual dilemmas involved in all anthropomorphic theology into one long catena of difficulty, out of which it is hard to conceive any free mind emerging with success. The third part (pp. 8–12) deals with the evolution of religion in the future, and formulates, more precisely than has ever yet been effected, the positive creed of Agnostic philosophy.

Has, then, the Agnostic a positive creed? It would seem so; for Mr. Spencer brings us at last "to the one absolute certainty, the presence of an Infinite and Eternal Energy, from which all things proceed." But let no one suppose that this is merely a new name for the Great First Cause of so many theologies and metaphysics. In spite of the capital letters, and the use of theological terms as old as Isaiah or Athanasius, Mr. Spencer's Energy has no analogy with God. It is Eternal, Infinite, and Incomprehensible; but still it is not He, but It. It remains always Energy, Force, nothing anthropomorphic; such as electricity, or anything else that we might conceive as the ultimate basis of all the physical forces. None of the positive attributes which

* See "Popular Science Monthly" for January, 1884.

have ever been predicated of God can be used of this Energy. Neither goodness, nor wisdom, nor justice, nor consciousness, nor will, nor life, can be ascribed, even by analogy, to this Force. Now a force to which we can not apply the ideas of goodness, wisdom, justice, consciousness, or life, any more than we can to a circle, is certainly not God, has no analogy with God, nor even with what Pope has called the "Great First Cause, least understood." It shares some of the negative attributes of God and First Cause, but no positive one. It is, in fact, only the Unknowable a little more defined ; though I do not remember that Mr. Spencer, or any evolution philosopher, has ever formulated the Unknowable in terms with so deep a theological ring as we hear in the phrase "Infinite and Eternal Energy, from which all things proceed."

The terms do seem, perhaps, rather needlessly big and absolute. And fully accepting Mr. Spencer's logical canons, one does not see why it should be called an "absolute certainty." "Practical belief" satisfies me ; and I doubt the legitimacy of substituting for it "absolute certainty." "Infinite" and "Eternal," also, can mean to Mr. Spencer nothing more than "to which we know no limits, no beginning or end," and, for my part, I prefer to say this. Again, "an Energy" —why AN Energy? The Unknowable may certainly consist of more than one energy. To assert the presence of one uniform energy is to profess to know something very important about the Unknowable : that it is homogeneous, and even identical, throughout the Universe. And then, "from which all things proceed" is perhaps a rather equivocal reversion to the theologic type. In the Athanasian Creed the Third Person "proceeds" from the First and the Second. But this process has always been treated as a mystery ; and it would be safer to avoid the phrases of mysticism. Let us keep the old words, for we all mean much the same thing ; and I prefer to put it thus. All observation and meditation, Science and Philosophy, bring us "to the *practical belief* that man is ever in the presence of *some energy or energies*, of which he knows nothing, and to which therefore he would be wise to assign no limits, conditions, or functions." This is, doubtless, what Mr. Spencer himself means. For my part, I prefer his old term, the Unknowable. Though I have always thought that it would be more philosophical not to assert of the Unknown that it is Unknowable. And, indeed, I would rather not use the capital letter, but stick literally to our evidence, and say frankly "the unknown."

Thus viewed, the attempt, so to speak, to put a little unction into the Unknowable is hardly worth the philosophical inaccuracy it involves ; and such is the drawback to any use of picturesque language. So stated, the positive creed of Agnosticism still retains its negative character. It has a series of propositions and terms, every one of which is a negation. A friend of my own, who was much pressed to say how much of the Athanasian Creed he still accepted, once said that he clung to the idea "that there was a sort of a something." In homely words such as the unlearned can understand, that is precisely what the religion of the Agnostic comes to, "the belief that there is a sort of a something about which we can know nothing."

Now let us profess that, as a philosophical answer to the theological problem, that is entirely our own position. The Positivist answer is of course the same as the Agnostic answer. Why, then, do we object to be called Agnostics? Simply because Agnostic is only dog-Greek for "don't know," and we have no taste to be called "don't knows." The "Spectator" calls us Agnostics, but that is only by way of prejudice. Our religion does not consist in a comprehensive negation; we are not forever replying to the theological problem; we are quite unconcerned by the theological problem, and have something that we do care for, and do know. Englishmen are Europeans, and many of them are Christians, and they usually prefer to call themselves Englishmen, Christians, or the like, rather than non-Asiatics or anti-Mahometans. Some people still prefer to call themselves Protestants rather than Christians, but the taste is dying out, except among Irish Orangemen, and even the Nonconformist newspaper has been induced by Mr. Matthew Arnold to drop its famous motto, "The dissidence of Dissent, and the Protestantism of the Protestant religion." For a man to say that his religion is Agnosticism is simply the skeptical equivalent of saying that his religion is Protestantism. Both mean that his religion is to deny and to differ. But this is not religion. The business of religion is to affirm and to unite, and nothing can be religion but that which at once affirms truth and unites men.

The purpose of the present paper is to show that Agnosticism, though a valid and final answer to the theological or ontological problem—"What is the ultimate cause of the world and of man?"—is not a religion nor the shadow of a religion. It offers none of the rudiments or elements of religion, and religion is not to be found in that line at all. It is the mere disembodied spirit of dead religion: as we said at the outset, it is the ghost of religion. Agnosticism, perfectly legitimate as the true answer of science to an effete question, has shown us that religion is not to be found anywhere within the realm of Cause. Having brought us to the answer, "no cause that we know of," it is laughable to call that negation religion. Mr. Mark Pattison, one of the acutest minds of modern Oxford, rather oddly says that the idea of deity has now been "defecated to a pure transparency." The evolution philosophy goes a step further and defecates the idea of cause to a pure transparency. Theology and ontology alike end in the Everlasting No with which science confronts all their assertions. But how whimsical is it to tell us that religion, which can not find any resting-place in theology or ontology, is to find its true home in the Everlasting No! That which is defecated to a pure transparency can never supply a religion to any human being but a philosopher constructing a system. It is quite conceivable that religion is to end with theology, and both might in the course of evolution become an anachronism. But if religion there is still to be, it can not be found in this No-man's-land and Know-nothing creed. Better bury religion at once than let its ghost walk uneasy in our dreams.

The true lesson is that we must hark back, and leave the realm of Cause. The accident of religion has been mistaken for the essence of religion. The essence of religion is not to answer a question, but to govern and unite men and societies by giving them common beliefs and duties. Theologies tried to do this, and long did it, by resting on certain answers to certain questions. The progress of thought has upset one answer after another, and now the final verdict of philosophy is that all the answers are unmeaning, and that no rational answer can be given. It follows then that questions and answers, both but the accident of religion, must both be given up. A base of belief and duty must be looked for elsewhere, and when this has been found, then again religion will succeed in governing and uniting men. Where is this base to be found? Since the realm of Cause has failed to give us foothold, we must fall back upon the realm of Law—social, moral, and mental law, and not merely physical. Religion consists, not in answering certain questions, but in making men of a certain quality. And the law, moral, mental, social, is pre-eminently the field wherein men may be governed and united. Hence to the religion of Cause there succeeds the religion of Law. But the religion of Law or Science is Positivism.

It is no part of my purpose to criticise Mr. Spencer's memorable essay, except so far as it is necessary to show that that which is a sound philosophical conclusion is not religion, simply by reason that it relates to the subject-matter of theology. But a few words may be suffered as to the historical evolution of religion. To many persons it will sound rather whimsical, and possibly almost a sneer, to trace the germs of religion to the ghost-theory. Our friends of the Psychical Research will prick up their ears, and expect to be taken *au grand sérieux.* But the conception is a thoroughly solid one, and of most suggestive kind. Beyond all doubt, the hypothesis of quasi-human immaterial spirits working within and behind familiar phenomena did take its rise from the idea of the other self which the imagination continually presents to the early reflections of man. And, beyond all doubt, the phenomena of dreams, and the gradual construction of a theory of ghosts, is a very impressive and vivid form of the notion of the other self. It would, I think, be wrong to assert that it is the only form of the notion, and one can hardly suppose that Mr. Spencer would limit himself to that. But, in any case, the construction of a coherent theory of ghosts is a typical instance of a belief in a quasi-human spirit-world. Glorify and amplify this idea, and apply it to the whole of Nature, and we get a god-world, a multitude of superhuman divine spirits.

That is the philosophical explanation of the rise of theology, of the peopling of Nature with divine spirits. But does it explain the rise of Religion? No, for theology and religion are not conterminous. Mr. Spencer has unwittingly conceded to the divines that which they assume so confidently—that theology is the same thing as religion, and that there was no religion at all until there was a belief in superhuman spirits within and behind Nature. This is obviously an oversight. We have to go very much further back for the genesis of religion. There were countless centuries of time, and there were, and there are, countless millions of men for whom no doctrine of superhuman spirits ever took coherent form. In all these ages and races, probably by far the most numerous that our planet has witnessed, there was religion in all kinds of definite form. Comte calls it Fetichism—terms are not important: roughly, we may call it Nature-worship. The religion in all these types was the belief and worship not of spirits of any kind, not of any immaterial, imagined being *inside* things, but of the actual visible things themselves—trees, stones, rivers, mountains, earth, fire, stars, sun, and sky. Some of the most abiding and powerful of all religions have consisted in elaborate worship of these physical objects treated frankly as physical objects, without trace of ghost, spirit, or god. To say nothing of fire-worship, river, and tree-worship, the venerable religion of China, far the most vast of all systematic religions, is wholly based on reverence for Earth, Sky, and ancestors treated objectively, and not as the abode of subjective immaterial spirits.

Hence the origin of religion is to be sought in the countless ages before the rise of theology; before spirits, ghosts, or gods ever took definite form in the human mind. The primitive uncultured man frankly worshiped external objects in love and in fear, ascribing to them quasi-human powers and feelings. All that we read about Animism, ghosts, spirits, and universal ideas of godhead in this truly primitive stage are metaphysical assumptions of men trying to read the ideas of later epochs into the facts of an earlier epoch. Nothing is more certain than that man everywhere started with a simple worship of natural objects. And the bearing of this on the future of religion is decisive. The religion of man in the vast cycles of primitive ages was reverence for Nature as influencing Man. The religion of man in the vast cycles that are to come will be the reverence for Humanity as supported by Nature. The religion of man in the twenty or thirty centuries of Theology was reverence for the assumed authors or controllers of Nature. But, that assumption having broken up, religion does not break up with it. On the contrary, it enters on a far greater and more potent career, inasmuch as the natural emotions of the human heart are now combined with the certainty of scientific knowledge. The final religion of enlightened man is the systematized and scientific form of the spontaneous religion of natural man. Both rest on the same elements—belief in the Power which controls his life, and grateful reverence for the Power so acknowledged. The primitive man thought that Power to be the object of Nature affecting Man. The cultured man knows that Power to be Humanity itself, controlling and controlled by Nature according to natural law. The transitional and perpetually changing creed of Theology has been an interlude. Agnosticism has uttered its epilogue. But Agnosticism is no more religion than differentiation or the nebular hypothesis is religion.

We have only to see what are the elements and ends of religion to recognize that we can not find it in the negative and the unknown. In any reasonable use of language religion implies some kind of belief in a Power outside ourselves, some kind of awe and gratitude felt for that Power, some kind of influence exerted by it over our lives. There are always in some sort these three elements—belief, worship, conduct. A religion which gives us nothing in particular to believe, nothing as an object of awe and gratitude, which has no special relation to human duty, is not a religion at all. It may be formula, a generalization, a logical postulate ; but it is not a religion. The universal presence of the unknowable (or rather of the unknown) substratum is not a religion. It is a logical postulate. You may call it, if you please, the first axiom of science, a law of the human mind, or perhaps better the universal postulate of philosophy. But try it by every test which indicates religion and you will find it wanting.

The points which the Unknowable has in common with the object of any religion are very slight and superficial. As the universal substratum it has some analogy with other superhuman objects of worship. But Force, Gravitation, Atom, Undulation, Vibration, and other abstract notions have much the same kind of analogy, but nobody ever dreamed of a religion of gravitation, or the worship of molecules. The Unknowable has managed to get itself spelt with a capital *U;* but Carlyle taught us to spell the Everlasting No with capitals also. The Unknowable is no doubt mysterious, and Godhead is mysterious. It certainly appeals to the sense of wonder, and the Trinity appeals to the sense of wonder. It suggests vague and infinite extension, as does the idea of deity: but then Time and Space equally suggest vague and infinite extension. Yet no one but a delirious Kantist ever professed that Time and Space were his religion. These seem all the qualities which the Unknowable has in common with objects of worship—ubiquity, mystery, and immensity. But these qualities it shares with some other postulates of thought.

But try it by all the other recognized tests of religion. Religion is not made up of wonder, or of a vague sense of immensity, unsatisfied yearning after infinity. Theology, seeking a refuge in the unintelligible, has no doubt accustomed this generation to imagine that a yearning after infinity is the sum and substance of religion. But that is a metaphysical disease of the age. And there is no reason that philosophers should accept this hysterical piece of transcendentalism, and assume that they have found the field of religion when they have found a field for unquenchable yearning after infinity. Wonder has its place in religion, and so has mystery ; but it is a subordinate place. The roots and fibers of religion are to be found in love, awe, sympathy, gratitude, consciousness of inferiority and of dependence, community of will, acceptance of control, manifestation of purpose, reverence for majesty, goodness, creative energy, and life. Where these things are not, religion is not.

Let us take each one of these three elements of religion—belief, worship, conduct—and try them all in turn as applicable to the Unknowable. How mere a phrase must any religion be of which neither belief, nor worship, nor conduct can be spoken ! Imagine a religion which can have no believers, because, *ex hypothesi*, its adepts are forbidden to believe anything about it. Imagine a religion which excludes the idea of worship, because its sole dogma is the infinity of Nothingness. Although the Unknowable is logically said to be Something, yet the something of which we neither know nor conceive anything is practically nothing. Lastly, imagine a religion which can have no relation to conduct ; for obviously the Unknowable can give us no intelligible help to conduct, and *ex vi termini* can have no bearing on conduct. A religion which could not make any one any better, which would leave the human heart and human society just as it found them, which left no foothold for devotion, and none for faith ; which could have no creed, no doctrines, no temples, no priests, no teachers, no rites, no morality, no beauty, no hope, no consolation ; which is summed up in one dogma—the Unknowable is everywhere, and Evolution is its prophet—this is indeed "to defecate religion to a pure transparency."

The growing weakness of religion has long been that it is being thrust inch by inch off the platform of knowledge ; and we watch with sympathy the desperate efforts of all religious spirits to maintain the relations between knowledge and religion. And now it hears the invitation of Evolution to abandon the domain of knowledge, and to migrate to the domain of no-knowledge. The true Rock of Ages, says the philosopher, is the Unknowable. To the eye of Faith all things are henceforth ἀκαταληψία, as Cicero calls it. The paradox would hardly be greater if we were told that true religion consisted in unlimited Vice.

What is religion for ? Why do we want it ? And what do we expect it to do for us ? If it can give us no sure ground for our minds to rest on, nothing to purify the heart, to exalt the sense of sympathy, to deepen our sense of beauty, to strengthen our resolves, to chasten us into resignation, and to kindle a spirit of self-sacrifice—what is the good of it ? The Unknowable, *ex hypothesi*, can do none of these things. The object of all religion, in any known variety of religion, has invariably had some quasi-human and sympathetic relation to man and human life. It follows from the very meaning of religion that it could not effect any of its work without such quality or relation. It would be hardly sane to make a religion out of the Equator or the Binomial theorem. Whether it was the religion of the lowest savage, of the Polytheist, or of the Hegelian Theist; whether the object of the worship were a river, the Moon, the Sky, Apollo, Thor, God, or First Cause, there has always been some chain of sympathy—influence on the one side, and veneration on the other. However rudimentary, there must be a belief in some Power influencing the believer, and whose influence he repays with awe and gratitude and a desire to conform his life thereto. But to make a religion out of the Unknowable is far more extravagant than to make it out of the Equator. We know something of the Equator; it influences seamen, equatorial peoples, and geographers not a little, and we all hesitate, as was once said, to speak disrespectfully of the Equator. But would it be blasphemy to speak disrespectfully of the Unknowable? Our minds are a blank about it. As to acknowledging the Unknowable, or trusting in it, or feeling its influence over us, or paying gratitude to it, or conforming our lives to it, or looking to it for help—the use of such words about it is unmeaning. We can wonder at it, as the child wonders at the "twinkling star," and that is all. It is a religion only to stare at.

Religion is not a thing of star-gazing and staring, but of life and action. And the condition of any such effect on our lives and our hearts is some sort of vital quality in that which is the object of the religion. The mountain, sun, or sky which untutored man worships is thought to have some sort of vital quality, some potency of the kind possessed by organic beings. When mountain, sun, and sky cease to have this vital potency, educated man ceases to worship them. Of course all sorts and conditions of divine spirits are assumed in a pre-eminent degree to have this quality, and hence the tremendous force exerted by all religions of divine spirits. Philosophy and the euthanasia of theology have certainly reduced this vital quality to a minimum in our day, and I suppose Dean Mansel's Bampton Lectures touched the low-water mark of vitality as predicated of the Divine Being. Of all modern theologians, the Dean came the nearest to the Evolution negation. But there is a gulf which separates even his all-negative deity from Mr. Spencer's impersonal, unconscious, unthinking, and unthinkable Energy.

Knowledge is of course wholly within the sphere of the Known. Our moral and social science is, of course, within the sphere of knowledge. Moral and social well-being, moral and social education, progress, perfection, naturally rest on moral and social science. Civilization rests on moral and social progress. And happiness can only be secured by both. But if religion has its sphere in the Unknown and Unknow, able, it is thereby outside all this field of the Known. In other words Religion (of the Unknowable type) is *ex hypothesi* outside the sphere of knowledge, of civilization, of social discipline, of morality, of progress, and of happiness. It has no part or parcel in human life. It fills a brief and mysterious chapter in a system of philosophy.

By their fruits you shall know them is true of all sorts of religion. And what are the fruits of the Unknowable but the Dead Sea apples? Obviously it can teach us nothing, influence us in nothing, for the absolutely incalculable and unintelligible can give us neither ground for action nor thought. Nor can it touch any one of our feelings, but that of wonder, mystery, and sense of human helplessness. Helpless, objectless, apathetic wonder at an inscrutable infinity may be attractive to a metaphysical divine: but it does not sound like a working force in the world. Does the Evolutionist commune with the Unknowable in the secret silence of his chamber? Does he meditate on it, saying, in quietness and confidence shall be your strength? One would like to see the new *Imitatio Ignoti*. It was said of old, *Ignotum omne pro magnifico*. But the new version is to be *Ignotum omne pro divino*.

One would like to know how much of the Evolutionist's day is consecrated to seeking the Unknowable in a devout way, and what the religious exercises might be. How does the man of science approach the All-Nothingness? and the microscopist, and the embryologist, and the vivisectionist? What do they learn about it, what strength or comfort does it give them? Nothing—nothing: it is an ever-present conundrum to be everlastingly given up, and perpetually to be asked of one's self and one's neighbors, but without waiting for the answer. Tantalus and Sisyphus bore their insoluble tasks, and the Evolutionist carries about his riddle without an answer, his unquenchable thirst to know that which he only knows he can never know. *Quisque suos patimur Manes*. But Tantalus and Sisyphus called it Hell and the retribution of the Gods. The Evolutionist calls it Religion, and one might almost say Paradise.

A child comes up to our Evolutionist friend, looks up in his wise and meditative face, and says, "O wise and great Master, what is religion?" And he tells that child, It is the presence of the Unknowable. "But what," asks the child, "am I to believe about it?" "Believe that you can never know anything about it." "But how am I to learn to do my duty?" "Oh! for duty you must turn to the known, to moral and social science." And a mother wrung with agony for the loss of her child, or the wife crushed by the death of her children's father, or the helpless and the oppressed, the poor and the needy, men, women, and children, in sorrow, doubt, and want, longing for something to comfort them and to guide them, something to believe in, to hope for, to love, and to worship—they come to our philosopher and they say, "Your men of science have routed our priests, and have silenced our old teachers. What religious faith do you give us in its place?" And the philosopher replies (his full heart bleeding for them) and he says, "Think on the Unknowable."

And in the hour of pain, danger, or death, can any one think of the Unknowable, hope anything of the Unknowable, or find any consolation therein? Altars might be built to some Unknown God, conceived as a real being, knowing us, though not known by us yet. But altars to the unknowable infinity, even metaphorical altars, are impossible, for this unknown can never be known, and we have not the smallest reason to imagine that it either knew us, or affects us, or anybody, or anything. As the Unknowable can not bring men together in a common belief, or for common purposes, or kindred feeling, it can no more unite men than the precession of the equinoxes can unite them. So there can never be congregations of Unknowable worshipers, nor churches dedicated to the Holy Unknowable, nor images nor symbols of the Unknowable mystery. Yes! there is one symbol of the Infinite Unknowable, and it is perhaps the most definite and ultimate word that can be said about it. The precise and yet inexhaustible language of mathematics enables us to express, in a common algebraic formula, the exact combination of the unknown raised to its highest power of infinity. That formula is (x^n), and here we have the beginning and perhaps the end of a symbolism for the religion of the Infinite Unknowable. Schools, academies, temples of the Unknowable, there can not be. But where two or three are gathered together to worship the Unknowable, there the algebraic formula may suffice to give form to their emotions: they may be heard to profess their unwearying belief in (x^n), even if no weak brother with ritualist tendencies be heard to cry, "O x^n, love us, help us, make us one with thee!"

These things have their serious side, and suggest the real difficulties in the way of the theory. The alternative is this: Is religion a mode of answering a question in ontology, or is it an institution for affecting human life by acting on the human spirit? If it be the latter, then there can be no religion of the Unknowable, and the sphere of religion must be sought elsewhere in the Knowable. We may accept with the utmost confidence all that the evolution philosophy asserts and denies as to the perpetual indications of an ultimate energy, omnipresent and unlimited, and, so far as we can see, of inscrutable mysteriousness. That remains an ultimate scientific idea, one no doubt of profound importance. But why should this idea be dignified with the name of religion, when it has not one of the elements of religion, except infinity and mystery? The hallowed name of religion has meant, in a thousand languages, man's deepest convictions, his surest hopes, the most sacred yearnings of his heart, that which can bind in brotherhood generations of men, comfort the fatherless and the widow, uphold the martyr at the stake, and the hero in his long battle. Why retain this magnificent word, rich with the associations of all that is great, pure, and lovely in human nature, if it is to be henceforth limited to an idea, that can only be expressed by the formula (x^n); and which by the hypothesis can have nothing to do with either knowledge, belief, sympathy, hope, life, duty, or happiness? It is not religion, this. It is a logician's artifice to escape from an awkward dilemma.

One word in conclusion to those who would see religion a working reality, and not a logical artifice. The startling *reductio ad absurdum* of relegating religion to the unknowable is only the last step in the process which has gradually reduced religion to an incomprehensible *minimum*. And this has been the work of theologians obstinately fighting a losing battle, and withdrawing at every defeat into a more impregnable and narrower fastness. They have thrown over one after another the claims of religion and the attributes of divinity. They are so hopeless of continuing the contest on the open field of the known that they more and more seek to withdraw to the cloud-world of the transcendental. They are so terribly afraid of an anthropomorphic God that they have sublimated him into a metaphorical expression—"defecated the idea to a pure transparency," as one of the most eminent of them puts it. Dean Mansel is separated from Mr. Spencer by degree, not in kind. And now they are pushed by Evolution into the abyss, and are solemnly assured that the reconciliation of Religion and Science is effected by this religion of the Unknowable—this *chimæra bombinans in vacuo.* Their Infinites and their Incomprehensibles, their Absolute and their Unconditioned, have brought them to this. It is only one step from the sublime to the unknowable.

Practically, so far as it affects the lives of men and women in the battle of life, the absolute and Unconditioned Godhead of learned divines is very much the same thing as the Absolute Unknowable. You may rout a logician by a "pure transparency," but you can not check vice, crime, and war by it, nor train up men and women in holiness and truth. And the set of all modern theology is away from the anthropomorphic and into the Absolute. In trying to save a religion of the spirit-world, theologians are abandoning all religion of the real world; they are turning religion into formulas and phrases, and are taking out of it all power over life, duty, and society.

I say, in a word, unless religion is to be anthropomorphic, there can be no working religion at all. How strange is this new cry, sprung up in our own generation, that religion is dishonored by being anthropomorphic! Fetichism, Polytheism, Confucianism, Mediæval Christianity, and Bible Puritanism have all been intensely anthropomorphic, and all owed their strength and dominion to that fact. You can have no religion without kinship, sympathy, relation of some human kind between the believer, worshiper, servant, and the object of his belief, veneration, and service. The Neo-Theisms have all the same mortal weakness that the Unknowable has. They offer no kinship, sympathy, or relation whatever between worshiper and worshiped. They, too, are logical formulas begotten in controversy, dwelling apart from man and the world. If the formula of the Unknowable is (x^n), or the Unknown raised to infinity, theirs is (nx), some unknown expression of Infinity. Neither (x^n) nor (nx) will ever make good men and women.

If we leave the region of formulas and go back to the practical effect of religion on human conduct, we must be driven to the conclusion that the future of religion is to be, not only what every real religion has ever been, anthropomorphic—but frankly anthropic. The attempted religion of Spiritism has lost one after another every resource of a real religion, until *risu solvuntur tabulæ*, and it ends in a religion of Nothingism. It is the Nemesis of Faith in spiritual abstractions and figments. The hypothesis has burst, and leaves the Void. The future will have then to return to the Knowable and the certainly known, to the religion of Realism. It must give up explaining the Universe, and content itself with explaining human life. Humanity is the grandest object of reverence within the region of the real and the known, Humanity with the World on which it rests as its base and environment. Religion, having failed in the superhuman world, returns to the human world. Here religion can find again all its certainty, all its depth of human sympathy, all its claim to command and reward the purest self-sacrifice and love. We can take our place again with all the great religious spirits who have ever molded the faith and life of men, and we find ourselves in harmony with the devout of every faith who are manfully battling with sin and discord. The way for us is the clearer as we find the religion of Spiritism, in its long and restless evolution of thirty centuries, ending in the legitimate deduction, the religion of the Unknowable, a paradox as memorable as any in the history of the human mind. The alternative is very plain. Shall we cling to a religion of Spiritism when Philosophy is whittling away spirit to Nothing? Or shall we accept a religion of Realism, where all the great traditions and functions of religion are retained unbroken?—*Nineteenth Century.*

RETROGRESSIVE RELIGION.*

BY HERBERT SPENCER.

In days when dueling was common, and its code of ceremonial well elaborated, a deadly encounter was preceded by a polite salute. Having by his obeisance professed to be his antagonist's very humble servant, each forthwith did his best to run him through the body.

* Excepting its last section, this article had been written, and part of it sent to the printers, by the 30th of May; and, consequently, before I saw the article of Sir James Stephen, published in the "Nineteenth Century" for June, 1884. Hence the fact that

This usage is recalled to me by the contrast between the compliment with which Mr. Harrison begins his article, "The Ghost of Religion," and the efforts he afterward makes to destroy, in the brilliant style habitual with him, all but the negative part of that which he applauds. After speaking with too-flattering eulogy of the mode in which I have dealt with current theological doctrines, he does his best, amid the flashes of wit coming from its polished surface, to pass the sword of his logic through the ribs of my argument, and let out its vital principle—that element in it which is derived from the religious ideas and sentiments that have grown up along with human evolution, but which is inconsistent with the creed Mr. Harrison preaches.

So misleading was the professed agreement with which he commenced his article, that, as I read on, I was some time in awakening to the fact that I had before me not a friend, but, controversially speaking, a determined enemy, who was seeking to reduce, as he would say to a ghostly form, that surviving element of religion which, as I had contended, Agnosticism contains. Even when this dawned on me, the suavity of Mr. Harrison's first manner continued so influential that I entertained no thought of defending myself. It was only after perceiving that what he modestly calls "a rider" was described by one journal as "a criticism keen, trenchant, destructive," while by some other journals kindred estimates of it were formed, that I decided to make a reply as soon as pending engagements allowed.

Recognizing, then, the substance of Mr. Harrison's article as being an unsparing assault on the essential part of that doctrine which I have set forth, I shall here not scruple to defend it in the most effective way I can: not allowing the laudation with which Mr. Harrison prefaces his ridicule, to negative such rejoinders, incisive as I can make them, as will best serve my purpose.

A critic who, in a recent number of the "Edinburgh Review," tells the world in very plain language what he thinks about a book of mine, and who has been taken to task by the editor of "Knowledge" for his injustice, refers to Mr. Harrison (whom he describes in felicitous phrase as looking at me from "a very opposite pole") as being, on one

only in its last section have I been able (without undue interruption of my argument) to refer to points in Sir James Stephen's criticism.

Concerning his criticism generally, I may remark that it shows me how dangerous it is to present separately, in brief space, conclusions which it has taken a large space to justify. Unhappily, twelve pages do not suffice for adequate exposition of a philosophical system, or even of its bases; and misapprehension is pretty certain to occur if a statement contained in twelve pages is regarded as more than a rude outline. If Sir James Stephen will refer to §§ 49–207 of the "Principles of Sociology," occupying 350 pages, I fancy that instead of seeming to him "weak," the evidence there given of the origin of religious ideas will seem to him very strong; and I venture also to think that if he will refer to "First Principles," §§ 24–26, § 50, §§ 58–61, § 194, and to the "Principles of Psychology," §§ 347–351, he may find that what he thinks "an unmeaning playing with words" has more meaning than appears at first sight.

point, in agreement with him.* But for this reference it would not have occurred to me to associate in thought Mr. Harrison's criticisms with those of the Edinburgh Reviewer; but now that comparison is suggested, I am struck by the fact that Mr. Harrison's representations of my views diverge from the realities no less widely than those of a critic whose antagonism is unqualified, and whose animus is displayed in his first paragraph.

So anxious is Mr. Harrison to show that the doctrine he would discredit has no kinship to the doctrines called religious, that he will not allow me, without protest, to use the language needed for conveying my meaning. The expression "an Infinite and Eternal Energy from which all things proceed," he objects to as being "perhaps a rather equivocal reversion to the theologic type;" and he says this because "in the Athanasian Creed the Third Person 'proceeds' from the First and the Second." It is hard that I should be debarred from thus using the word by this preceding use. Perhaps Mr. Harrison will be surprised to learn that, as originally written, the expression ran —"an Infinite and Eternal Energy by which all things are created and sustained;" and that in the proof I struck out the last clause because, though the words did not express more than I meant, the ideas associated with them might mislead, and there might result such an insinuation as that which Mr. Harrison makes. The substituted expression, which embodies my thought in the most colorless way, I can not relinquish because he does not like it—or rather, indeed, because he does not like the thought itself. It is not convenient to him that the Unknowable, which he repeatedly speaks of as a pure negation, should be represented as that through which all things exist. And, indeed, it would be inconvenient for him to recognize this; since the recognition would prevent him from asserting that "none of the positive attributes which have ever been predicated of God can be used of this Energy."

Not only does he, as in the last sentence, negatively misdescribe the character of this Energy, but he positively misdescribes it. He says—"It remains always Energy, Force: nothing anthropomorphic; such as electricity, or anything else that we might conceive as the ultimate basis of all the physical forces." Now, on page 9 of the essay Mr. Harrison criticises, there occurs the sentence—"The final outcome of that speculation commenced by the primitive man, is that the Power manifested throughout the Universe distinguished as material, is the same power which in ourselves wells up under the form of consciousness;" and on page 11 it is said that "this necessity we are under, to think of the external energy in terms of the internal energy, gives rather a spiritualistic than a materialistic aspect to the Universe." Does he really think that the meaning of these sentences is conveyed by comparing the ultimate energy to "electricity"? And does he

* "Knowledge," March 14, 1884.

think this in face of the statement on page 11 that "phenomenal manifestations of this ultimate energy can in no wise show us what it is?" Surely that which is described as the substratum at once of material and mental existence, bears toward us and toward the Universe, a relation utterly unlike that which electricity bears to the other physical forces.

Persistent thinking along defined grooves, causes inability to get out of them; and Mr. Harrison, in more than one way, illustrates this. So completely is his thought molded to that form of phenomenalism entertained by M. Comte, that, in spite of repeated denials of it, he ascribes it to me; and does this in face of the various presentations of an opposed phenomenalism, which I have given in the article he criticises and elsewhere. Speaking after his lively manner of the Unknown Cause as "an ever-present conundrum to be everlastingly given up," he asks—"How does the man of science approach the All-Nothingness?" Now M. Comte describes Positivism as becoming perfect when it reaches the power to "se représenter tous les divers phénomènes observables comme des cas particuliers d'un seul fait général . . . considérant comme absolument inaccessible, et vide de sens pour nous, la recherche de ce qu'on appelle les *causes*, soit premières, soit finales;" * and in pursuance of this view the Comtean system limits itself to phenomena, and deliberately ignores the existence of anything implied by the phenomena. But though M. Comte thus exhibits to us a doctrine which, performing "the happy dispatch," eviscerates things and leaves a shell of appearances with no reality inside; yet I have in more than one place, and in the most emphatic way, declined thus to commit intellectual suicide. So far from regarding that which transcends phenomena as the "All-Nothingness," I regard it as the All-Being. Everywhere I have spoken of the Unknowable as the Ultimate Reality—the sole existence: all things present to consciousness being but shows of it. Mr. Harrison entirely inverts our relative positions. As I understand the case, the "All-Nothingness" is that phenomenal existence in which M. Comte and his disciples profess to dwell—profess, I say, because in their ordinary thoughts they recognize an existence transcending phenomena just as much as other people do.

That the opposition between the view actually held by me and the view ascribed to me by Mr. Harrison, is absolute, will be most clearly seen on observing the contrast he draws between my view and the view of the late Dean Mansel. He says:—

> Of all modern theologians, the Dean came the nearest to the evolution negation. But there is a gulf which separates even his all-negative deity from Mr. Spencer's impersonal, unconscious, unthinking, and unthinkable energy.

It is quite true that there exists this gulf. But then the propositions forming the two sides of the gulf are the opposites of those which Mr.

* "Système de Philosophie Positive," vol. i, pp. 5, 14.

Harrison represents. For whereas, in common with his teacher Sir William Hamilton, Dean Mansel alleged that our consciousness of the Absolute is merely "a negation of conceivability;" I have, over a space of ten pages,* contended that our consciousness of the Absolute is not negative but positive, and is the one indestructible element of consciousness "which persists at all times, under all circumstances, and can not cease until consciousness ceases"—have argued that while the Power which transcends phenomena can not be brought within the forms of our finite thought, yet that, as being a necessary datum of every thought, belief in its existence has, among our beliefs, the highest validity of any; is not, as Sir W. Hamilton alleges, a belief with which we are supernaturally "inspired," but is a normal deliverance of consciousness. Thus, as represented by Mr. Harrison, Dean Mansel's views and my own are exactly transposed. Misrepresentation could not, I think, go further.

The conception I have everywhere expressed and implied, of the relation between human life and the Ultimate Cause, if not diametrically opposed with like distinctness to the conception Mr. Harrison ascribes to me, is yet thus opposed in an unmistakable way. After suggesting that (x^n) would be an appropriate symbol "for the religion of the Infinite Unknowable," and amusing himself and his readers by imaginary prayers made to (x^n); after making a subsequent elaboration of his *jeu d'esprit* by suggesting that (nx) would serve for the formula of certain modern Theisms, he says of these :—

> The Neo-Theisms have all the same mortal weakness that the Unknowable has. They offer no kinship, sympathy, or relation whatever between worshiper and worshiped. They, too, are logical formulas begotten in controversy, dwelling apart from man and the world.

Now, considering that in the article he has before him there is in various ways implied the view that "the power which manifests itself in consciousness is but a differently conditioned form of the power which manifests itself beyond consciousness"—considering that here and everywhere throughout my books the implication is that our lives, alike physical and mental, in common with all the activities, organic and inorganic, amid which we live, are but the workings of this Power, it is not a little astonishing to find it described as simply a "logical formula begotten in controversy." Does Mr. Harrison really think that he represents the facts when he describes as "dwelling apart from man and the world," that Power of which man and the world are regarded products, and which is manifested through man and the world from instant to instant?

Did I not need the space for other topics, I might at much greater length contrast Mr. Harrison's erroneous versions with the true ones. I might enlarge on the fact that, though the name Agnosticism fitly

* "First Principles," § 26.

expresses the confessed inability to know or conceive the nature of the Power manifested through phenomena, it fails to indicate the confessed ability to recognize the existence of that Power as of all things the most certain. I might make clear the contrast between that Comtean Agnosticism which says that "Theology and ontology alike end in the Everlasting No with which science confronts all their assertions,"* and the Agnosticism set forth in "First Principles," which, along with its denials, emphatically utters an Everlasting Yes. And I might show in detail that Mr. Harrison is wrong in implying that Agnosticism, as I hold it, is anything more than silent with respect to the question of personality; since, though the attributes of personality, as we know it, can not be conceived by us as attributes of the Unknown Cause of things, yet "duty requires us neither to affirm nor deny personality," but "to submit ourselves with all humility to the established limits of our intelligence" in the conviction that the choice is not "between personality and something lower than personality," but "between personality and something higher,"† and that "the Ultimate Power is no more representable in terms of human consciousness than human consciousness is representable in terms of a plant's functions."‡

But without further evidence, what I have said sufficiently proves that Mr. Harrison's "criticism keen, trenchant, destructive," as it was called, is destructive, not of an actual doctrine, but simply of an imaginary one. I should hardly have expected that Mr. Harrison, in common with the "Edinburgh Reviewer," would have taken the course, so frequent with critics, of demolishing a simulacrum and walking off in triumph as though the reality had been demolished. Adopting his own figure, I may say that he has with ease passed his weapon through and through "The Ghost of Religion;" but then it is only the ghost: the reality stands unscathed.

Before passing to the consideration of that alternative doctrine which Mr. Harrison would have us accept, it will be well briefly to deal with certain of his subordinate propositions.

After re-stating in a succinct way, the hypothesis that from the conception of the ghost originated the conceptions of supernatural beings in general, including the highest, and after saying that "one can hardly suppose that Mr. Spencer would limit himself to that," Mr. Harrison describes what he alleges to be a prior, and, indeed, the primordial, form of religion. He says:—

> There were countless centuries of time, and there were, and there are, countless millions of men for whom no doctrine of superhuman spirits ever took coherent form. In all these ages and races, probably by far the most numerous that our planet has witnessed, there was religion in all kinds of definite form. Comte calls it fetichism—terms are not important: roughly, we may call it

* Harrison, *loc. cit.*, p. 497.

† "First Principles," § 31.

‡ "Essays," vol. iii, p. 251.

nature-worship. The religion in all these types was the belief and worship not of spirits of any kind, not of any immaterial, imagined being *inside* things, but of the actual visible things themselves—trees, stones, rivers, mountains, earth, fire, stars, sun, and sky. (P. 498.)

The attitude of discipleship is not favorable to inquiry; and, as fanatical Christians show us, inquiry is sometimes thought sinful and likely to bring punishment. I do not suppose that Mr. Harrison's reverence for M. Comte has gone this length; but still it has gone far enough not only to cause his continued adherence to a doctrine espoused by M. Comte which has been disproved, but also to make him tacitly assume that this doctrine is accepted by one whose rejection of it was long ago set forth. In the "Descriptive Sociology" there are classified and tabulated statements concerning some eighty peoples; and besides these I have had before me masses of facts, since collected, concerning many other peoples. An induction based on over a hundred examples, warrants me in saying that there has never existed anywhere such a religion as that which Mr. Harrison ascribes to "countless millions of men" during "countless centuries of time." A chapter on "Idol-worship and Fetich-worship" in the "Principles of Sociology," gives proof that in the absence of a developed ghost-theory, fetichism is absent. I have shown that, whereas among the lowest races, such as the Juángs, Andamanese, Fuegians, Australians, Tasmanians, and Bushmen, there is no fetichism; fetichism reaches its greatest height in considerably-advanced societies, like those of ancient Peru and modern India: in which last place, as Sir Alfred Lyall tells us, "not only does the husbandman pray to his plow, the fisher to his net, the weaver to his loom, but the scribe adores his pen, and the banker his account-books.* And I have remarked that, "had fetichism been conspicuous among the lowest races, and inconspicuous among the higher, the statement that it was primordial might have been held proved; but that as the facts happen to be exactly the opposite, the statement is conclusively disproved." †

Similarly with Nature-worship: regarding this as being partially distinguished from Fetichism by the relatively imposing character of its objects. In a subsequent chapter I have shown that this also, is an aberrant development of ghost-worship. Among all the many tribes and nations, remote in place and unlike in type, whose superstitions I have examined, I have found no case in which any great natural appearance or power, feared and propitiated, was not identified with a human or quasi-human personality. I am not aware that Professor Max Müller, or any adherent of his, has been able to produce a single case in which there exists worship of the great natural objects themselves, pure and simple—the heavens, the sun, the moon, the dawn, etc.: objects which, according to the mythologists, become

* "Religion of an Indian Province." † "Principles of Sociology," § 162.

personalized by "a disease of language." Personalization exists at the outset; and the worship is in all cases the worship of an indwelling ghost-derived being.

That these conclusions are necessitated by an exhaustive examination of the evidence, is shown by the fact that they have been forced on Dr. E. B. Tylor notwithstanding his original enunciation of other conclusions. In a lecture "On Traces of the Early Mental Condition of Man," delivered at the Royal Institution on the 15th of March, 1867, he said:—

> It is well known that the lower races of mankind account for the facts and events of the outer world by ascribing a sort of human life and personality to animals, and even to plants, rocks, streams, winds, the sun and stars, and so on through the phenomena of nature. . . . It would probably add to the clearness of our conception of the state of mind which thus sees in all nature the action of animated life and the presence of innumerable spiritual beings, if we gave it the name of Animism instead of Fetichism.

Here, having first noted that the conception of Fetichism derived by Dr. Tylor from multitudinous facts, is not like that of Mr. Harrison, who conceives Fetichism to be a worship of the objects themselves, and not a worship of their indwelling spirits, we further note that Dr. Tylor regards this ascription of souls to all objects, inanimate as well as animate, which he proposes to call Animism rather than Fetichism, as being primordial. In the earlier part of his "Primitive Culture," published in 1871, we find a re-statement of this view; but further on we observe a modification of it, as instance the following sentence in vol. ii, p. 100.

> It seems as though the conception of a human soul, when once attained to by man, served as a type or model on which he framed not only his ideas of other souls of lower grade, but also his ideas of spiritual beings in general, from the tiniest elf that sports in the long grass, up to the heavenly Creator and Ruler of the world, the Great Spirit.

And then, in articles published in "Mind" for April and for July, 1877, Dr. Tylor represented himself as holding a doctrine identical with that set forth by me in the "Principles of Sociology"; namely, that the belief in a human ghost is original, and that the beliefs in spirits inhabiting inanimate objects, giving rise to Fetichism and Nature-worship, are derived beliefs.

An emphatic negative is thus given to Mr. Harrison's assertion that "Nothing is more certain than that man everywhere started with a simple worship of natural objects." And if he holds that "the bearing of this on the future of religion is decisive"—if, as he says, "the religion of man in the vast cycles of primitive ages was reverence for nature as influencing Man," and if, as he infers, "the religion of man in the vast cycles that are to come will be the reverence for Humanity as supported by Nature"—if, as it thus seems, primitive religion as conceived by him is a basis for what he conceives to be the religion of the future; then his conception of the religion of the future is, in so far, baseless.

And now I come to the chief purpose of this article—an examination of that alternative faith which Mr. Harrison has on sundry occasions set forth with so much eloquence. As originally designed, the essay, "Religion: a Retrospect and Prospect," was to include a section in which, before considering what the future of religion was likely to be, I proposed to consider what its future was *not* likely to be; and the topic to be dealt with in this section was the so-called Religion of Humanity. After collecting materials and writing ten pages, I began to perceive that, besides being not needful for my purpose, this section would form too large an excrescence. A further feeling came into play. Though I had for many years looked forward to the time when an examination of the Positivist creed would fall within the lines of my work, yet when I began to put on paper that which I had frequently thought, it seemed to me that I was making an uncalled-for attack on men whom I had every reason to admire for their high characters and their unwearying efforts for human welfare. The result was that I put aside what I had written, and gave up my long-cherished intention. Now, however, that Mr. Harrison has thrown down the gauntlet, I take it up, at once willingly and unwillingly—willingly in so far as acceptance of the challenge is concerned, unwillingly because I feel some reluctance in dealing hard blows at a personal friend.

Surprise has been the feeling habitually produced in me on observing the incongruity between the astounding claims made by the propounder of this new creed, and the great intelligence of disciples whose faith appears proof against the shock which these astounding claims produce on ordinary minds. Those who, from a broad view of human progress, have gained the general impression that "The individual withers, and the world is more and more," must be disinclined to believe that in the future any one individual will impose on the world a government like that sought to be imposed by M. Comte; who, unable to influence any considerable number of men while he lived, consoled himself with the thought of absolutely ruling all men after his death. Met, as he complained, by "a conspiracy of silence," he was nevertheless confident that, very shortly becoming converts, mankind at large would hereafter live and move and have their being within his elaborated formulas. Papal assumption is modest compared with the assumption of "the founder of the religion of Humanity." A single pope may canonize a saint or two; but M. Comte undertook the canonization of all those men recorded in history whom he thought specially worthy of worship. And such a canonization!—days assigned for the remembrance with honor of mythical personages like Hercules and Orpheus, and writers such as Terence and Juvenal; other days on which honors, like in degree, are given to Kant and to Robertson, to

Bernard de Palissy and to Schiller, to Copernicus and to Dollond, to Otway and to Racine, to Locke and to Fréret, to Froissart and to Dalton, to Cyrus and to Penn—such a canonization! in which these selected men who are the Positivist saints for ordinary days, are headed by greater saints for Sundays; with the result that Socrates and Godfrey are thus placed on a par; that while a day is dedicated to Kepler, a week is dedicated to Gall; Tasso has a week assigned to him, and Goethe a day; Mozart presides over a week, and a day is presided over by Beethoven; a week is made sacred to Louis the Eleventh, and a day to Washington—such a canonization! under which the greatest men, giving their names to months, are so selected that Frederic the Second and St. Paul alike bear this distinction; Gutemberg and Shakespeare head adjacent months; and while Bichat gives his name to a month, Newton gives his name to a week! This, which recalls the saints' calendar of the Babylonians, among whom, as Professor Sayce shows, "each day of the year had been assigned to its particular deity or patron saint," * exemplifies in but one way M. Comte's consuming passion for regulating posterity, and the colossal vanity which led him to believe that mankind would hereafter perform their daily actions as he dictated. He not only settles the hierarchy of saints who are above others to be worshiped, but he prescribes the forms of worship in minute detail. Nine sacraments are specified; prayer is to be made thrice a day; for the "daily expression of their emotions both in public and private" it is suggested that future men should use Italian; † and it is a recommended "rule of worship" of the person you adore, that "a precise idea of the place, next of the seat or the attitude, and, lastly, of the dress, appropriate to each particular case," ‡ should be summoned before the mind. Add to which that in the elaborate rubric the sacred sign (replacing the sign of the cross) and derived "from our cerebral theory" (he had a phrenology of his own) consists in placing "our hand in succession on the three chief organs—those of love, order, and progress." Of banners used in "solemn processions," it is directed that "on their white side will be the holy image; on their green, the sacred formula of Positivism;" and "the symbol of our Divinity will always be a woman of the age of thirty, with her son in her arms." # Nor was M. Comte's devouring desire to rule the future satisfied with thus elaborating the observances of his cult. He undertook to control the secular culture of men, as well as that culture which, I suppose, he distinguished as sacred. There is "a Positivist library for the nineteenth century," consisting of 150 volumes: the list being compiled for the purpose "of guiding the more thoughtful minds." ‖ So that M. Comte's tastes and judgments in poetry, science, history, etc., are to be the standards for future generations. And the numerous regulations of

* "Records of the Past," vol. vii, p. 157. † "System of Positive Polity," vol. iv, p. 85.
‡ "Catechism," p. 100. # "Catechism of Positivism," pp. 142, 143. ‖ Ibid., p. 38.

these kinds are in addition to the other multitudinous regulations contained in those parts of the highly elaborated "System of Positive Polity," in which M. Comte prescribes the social organization, under the arrangements of which "the affective, speculative, patrician, and plebeian" classes are to carry on the business of their lives.

It is, I say, not a little remarkable that a height of assumption exceeding that ever before displayed by a human being—a self-deification along with the deification of Humanity—should not have negatived belief in the general doctrines set forth by him. One might have thought that by exhibiting a lack of mental balance unparalleled among sane people, he would have wholly discredited his speculations. However, recognizing the fact that this is not so, and assuming that M. Comte's disciples discover in the Religion of Humanity propounded by him, a truth which survives recognition of his—eccentricities, let us call them—we will now go on to consider this proposed creed.

To those who have studied that natural genesis of religion summarized in the article Mr. Harrison criticises,* it will appear anomalous that a proposed new and higher religion should be, in large measure, a rehabilitation of the religion with which mankind commenced, and from which they have been insensibly diverging, until the more advanced among them have quite lost sight of it. After an era during which worship of the dead was practiced all the world over, alike by savages and by the progenitors of the civilized—after an era of slow emergence from this primitive religion, during which the propitiation of ghosts completely human was replaced by the propitiation of comparatively few superhuman ghosts or spirits, and finally by the propitiation of a spirit infinitely transcending humanity, and from which human attributes have been gradually dropped, leaving only the most abstract which are themselves fading ; we are told by the Positivists that there is coming an era in which the Universal Power men have come to believe in, will be ignored; and human individualities, regarded now singly and now in their aggregate, will again be the objects of religious feeling. If the worship of the dead is not to be completely resuscitated, still the proposal is to resuscitate it in a form but partially transfigured. Though there is no direction to offer at graves food and drink for ghosts, yet public worship of the so-called "Great Being Humanity," "must be performed in the midst of the tombs of the more eminent dead, which tombs are surrounded by a sacred grove, the scene of the homage paid by their family and their fellow-citizens;" † while "at times within each consecrated tomb, the priesthood will" superintend the honoring of the good man or woman: ‡ proposed usages analogous to those of many ancestor-worshiping peoples. Moreover, again taking a lesson from various races of pagans,

* And set forth at length in "The Principles of Sociology," Part I.

† "Positive Polity," vol. iv, p. 139.

‡ "Catechism," p. 137.

past and present, there is to be "a domestic altar," at which, in kneeling attitude, adoration is to be paid to "our own personal patrons, our guardian angels, or household gods:" * these being persons living or dead. And as exemplified by M. Comte's worship of Clotilde de Vaux, the praying to a beloved person or wife may be continued for years; recalling the customs of multitudinous peoples who invoke departed members of their families, as instance the Balonda, among whom if the "spot where a favorite wife has died," . . . "is revisited, it is to pray to her." †

Now omitting for the present all thought about the worthiness of these objects of worship, and considering only the general nature of the system, there arises the question—How happens it that while in other respects M. Comte delineates human evolution as progressive, he, in this respect, delineates it as retrogressive? Beyond all question civilization has been a gradual divergence from primitive savagery. According to his own account, the advance in social organization, in knowledge, in science, in art, presents a certain general continuity. Even in speculative thought, M. Comte's formula of the three stages, the theological, the metaphysical, and the positive, tacitly asserts movements in the same direction toward a final theory. How happens it, then, that with an advancing change in other things, there is to occur a retreating change in one thing?—along with progression in all else, retrogression in religion?

This retrogressive character of the Comtean religion is shown in sundry other ways—being, indeed, sometimes distinctly admitted or avowed. Thus we are told that "the domain of the priesthood must be reconstituted in its integrity; medicine must again become a part of it," ‡ as from savage life upward it was until modern times. Again, education has been slowly emancipating itself from ecclesiasticism; but in M. Comte's scheme, after the sacrament of initiation, the child passes "from its unsystematic training under the eye of its mother to the systematic education given by the priesthood;" # just as, after a parallel ceremony, the child does among the Congo people,‖ and as it did among the ancient Mexicans.^ And knowingly or unknowingly, M. Comte followed the lead of the Egyptians who had a formal judging of the dead by the living: honorable burial was allowed by them only in the absence of accusations against the deceased proved before judges; and by M. Comte it is provided that after a prescribed interval, the priesthood shall decide whether the remains shall be transferred from their probationary resting-place to "the sacred wood" reserved for the "sanctified." Most remarkable of all, however, is the reversion to an early type of religious belief

* "Positive Polity," vol. iv, pp. 100, 101.

† Livingstone, "South Africa," p. 314.

‡ "Catechism," p. 50.

\# "Catechism," p. 129.

‖ Bastian (A.), "Africanische Reisen," p. 85.

^ Torquemada (Juan de), "Monarquia Indiana," book ix, chaps. xi to xiii.

in the prescribed worship of objects, animate and inanimate. In "Table A, System of Sociolatry," there are times named for the "Festival of the Animals," "Festival of Fire," "Festival of the Sun," "Festival of Iron," etc.

But now, passing over M. Comte's eccentricities and inconsistencies, let us consider on its merits the creed he enunciated. In addition to private worship of guardian angels or household gods, there is to be a public worship of the "Great Being Humanity." How are we to conceive this Great Being? Various conceptions of it are possible; and more or less unlike conceptions are at one time or other presented to us. Let us look at them in succession.

By M. Comte himself, at page 74 of the "Catechism of Positive Religion," we are told that we must—

define Humanity as the whole of human beings, past, present, and future. The word *whole* points out clearly that you must not take in all men, but those only who are really capable of assimilation, in virtue of a real co-operation on their part in furthering the common good.

On which the first comment suggesting itself is that the word "*whole* points out clearly" not limitation, but absence of limitation. Passing over this, however, and agreeing to exclude, as is intended, criminals, paupers, beggars, and all who "remain in the parasitic state," it seems that we are to include in the aggregate object of our worship, all who have aided, now aid, and will hereafter aid, social growth and development. Though elsewhere* it is limited to those who "co-operate willingly," yet since "the animals which voluntarily aid man" are recognized as "integral portions of the Great Being," and since the co-operation of slaves is as "voluntary" as that of horses, we seem compelled to include, not the superior men and classes only, but even those who, under a coercion such as is used to domestic animals, have helped to subdue the Earth and further the material progress of Humanity. And since the progress of Humanity has been largely aided by the spread of the higher races and accompanying extermination of the lower races, we must comprehend in our conception of this worshipful Great Being all those who, from the earliest savage times, have, as leading warriors and common soldiers, helped by their victories to replace inferior societies by superior ones; not only bloodthirsty conquerors like Sesostris (who is duly sanctified in the calendar) but even such cannibals as the Aztecs, who laid the basis of the Mexican civilization.

So far from seeing in the "Great Being Humanity," as thus defined, anything worshipful, it seems to me that contemplation of it is calculated to excite feelings which it is best to keep out of consciousness.

But now, not to take the doctrine at a disadvantage, let us conceive the object of the Positivist's adoration under a better aspect.

* "Catechism," p. 427.

Let us consider what claims to godhood may be made for the Humanity immediately known to us. Unquestionably M. Comte's own doctrine, that there has been going on an evolution of mankind, implies that such portion of the "Great Being Humanity" as is formed by our own generation, is better than the average of those portions which have heretofore lived and died. What then shall we say of this better portion?

Of course we must keep out of thought all the bad conduct going on around—the prevailing dishonesty shown in adulteration by retailers and production of debased goods by manufacturers, the inefficient and dawdling work of artisans, the many fraudulent transactions of which a few are daily disclosed at trials; though why we are to exclude the blameworthy from our conception of Humanity, I do not understand. But not dwelling on this, let us contemplate first the intellectual traits, and then the moral traits, of the people who remain after leaving out the worse.

Those whose mental appetites are daily satisfied by table talk almost wholly personal, by gossiping books and novels, and by newspapers the contents of which are usually enjoyed the more in proportion as there is in them much of the scandalous or the horrible—those who, on Sunday, never working out their own beliefs, receive the weekly dole of thought called for by their state of spiritual pauperism—those who, to the ideas they received during education, add only such as are supplied by daily journals and weekly sermons, with now and then a few from books, having none of their own worth speaking of; we may be content to class as respectable in the conventional sense, though scarcely in any higher sense—still less to include them as chief components in a body exciting reverence. Even if we limit attention to those of highest culture, including all who are concerned in regulative functions, political, ecclesiastical, educational, or other, the displays of intelligence do not call forth such an emotion as that which M. Comte's theory requires us to entertain. What shall we say of the wisdom of those, including nearly all who occupy influential positions, who persist in thinking that preparation for successful and complete living (which is the purpose of rational education) is best effected by learning to speak and write after the manner of two extinct peoples, and by gaining knowledge of their chief men, their superstitions, their deeds of war, etc.—who, in their leading school, devote two hours per week to getting some ideas about the constitution of the world they are born into, and thirty-six hours per week to construing Latin and Greek and making verses, nonsensical or other; and who, in the competitive examinations they devise, give to knowledge of words double the number of marks which they give to knowledge of things? That, it seems to me, is not a very worshipful degree of intelligence which fails to recognize the obvious truth that there is an Order of Nature, pervading alike the actions going on within us and without us, to which, from moment to moment, our lives must conform under penalty of one or other evil; and that therefore our first business must be to study this Order of Nature. Nor is estimation of this intelligence raised on contemplating the outcome of this established culture, as seen in Parliament; where any proposal to judge a question by reference to general laws, or "abstract principles" as they are called, is pooh-poohed, with the tacit implication that in social affairs there is no natural law; and where, as we lately saw, 300 select spokesmen of the nation cheered frantically when it was decided that they should continue to vow before God that they would maintain certain arrangements prescribed for them by their great, great, great, etc. grandfathers.

On turning to the moral manifestations, we find still less that is calculated to excite the required religious feeling. When multitudes of citizens belonging to the classes distinguished as "the better," make a hero of a politician whose sole aim throughout life was success, regardless of principle, and have even established an annual commemoration of him, we are obliged to infer that the prevailing sentiments are not of a very high order. Nothing approaching to adoration is called forth by those who, on the death of a youth who went to help in killing Zulus, with whom he had no quarrel, and all that he might increase his chance of playing despot over the French, thought him worthy of high funeral honors—would, many of them, indeed, have given him the highest. No feeling of reverence arises in one's mind on thinking of people who looked on with approval or tolerance when a sailor of fortune, who has hired himself out to an eastern tyrant to slay at the word of command, was honored here by a banquet. A public opinion which recognizes no criminality in wholesale homicide so long as it is committed by a constituted political authority, no matter how vile, or by its foreign hired agent who is indifferent to the right or wrong of the question at issue, is a public opinion which excites, in some at any rate, an emotion nearer to contempt than to adoration.

This emotion is not changed on looking abroad and contemplating the implied natures of those who guide, and the implied natures of those who accept the guidance. When, among a people professing that religion of peace preached to them generation after generation by tens of thousands of priests, an assembly receives with enthusiasm, as lately at the Gambetta dinner, the toast, "The French army, the highest embodiment of the French nation"—when, along with nominal acceptance of forgiveness as a Christian duty, there goes intense determination to retaliate; we are obliged to reprobate either the feeling which they actually think proper, or the hypocrisy with which they profess that the opposite feeling is proper. On finding in another advanced society that the seats of highest culture are seats of discipline in barbarism, where the test of manhood is the giving and taking of wounds in fights arising from trivial causes or none at all, and where, last year, a single day witnessed twenty-one such encounters in one university; we are reminded more of North American Indians, among whom tortures constitute the initiation of young men, than of civilized people taught for a thousand years to do good even to enemies. Or when we see, as lately in a nation akin to the last, that an officer who declined to break at once the law of his country and the law of his religion by fighting a duel, was expelled the army; we are obliged to admit that profession of a creed which forbids revenge, by those whose deeds emphatically assert revenge to be a duty (almost as emphatically as do the lowest races of men), presents Humanity under an aspect not at all of the kind which we look for in "the adorable Great Being." Not reverence, not admiration, scarcely even respect, is caused by the sight of a hundred million Pagans masquerading as Christians.

I am told that by certain of M. Comte's disciples (though not by those Mr. Harrison represents) prayer is addressed to "holy" Humanity. Had I to choose an epithet, I think "holy" is about the last which would occur to me.

"But it is only the select human beings—those more especially who are sanctified in the Comtist calendar—who are to form the object of worship; and, for the worship of such, there is the reason that they are the benefactors to whom we owe everything."

On the first of these statements, made by some adherents of M. Comte, one remark must be that it is at variance with M. Comte's own definition of the object of worship, as quoted above; and another remark must be that, admitting such select persons to be worshipful (and I do not admit it), there is no more reason for worshiping Humanity as a whole on the strength of these best samples, than there is for worshiping an ordinary individual, or even a criminal, on the strength of the few good actions which qualified the multitudinous indifferent actions and bad actions he committed. The second of these statements, that Humanity, either as the whole defined by M. Comte or as represented by these select persons, must be adored as being the producer of everything which civilization has brought us, and, in a measure, even the creator of our higher powers of thought and action, we will now consider. Let us hear M. Comte himself on this point:

> Thus each step of sound training in positive thought awakens perpetual feelings of veneration and gratitude; which rise often into enthusiastic admiration of the Great Being, who is the author of all these conquests, be they in thought, or be they in action.*

What may have been the conceptions of "veneration and gratitude" entertained by M. Comte, we can not, of course, say; but if

* "System of Positive Polity," vol. ii, p. 45.

any one not a disciple will examine his consciousness, he will, I think, quickly perceive that veneration or gratitude felt toward any being, implies belief in the conscious action of that being—implies ascription of a prompting motive of a high kind, and deeds resulting from it: gratitude can not be entertained toward something which is unconscious. So that the "Great Being Humanity" must be conceived as having in its incorporated form, ideas, feelings, and volitions. Naturally there follows the inquiry—"Where is its seat of consciousness?" Is it diffused throughout mankind at large? That can not be; for consciousness is an organized combination of mental states, implying instantaneous communications such as certainly do not exist throughout Humanity. Where, then, must be its center of consciousness? In France, of course, which, in the Comtean system, is to be the leading State; and naturally in Paris, to which all the major axes of the temples of Humanity are to point. Any one with adequate humor might raise amusing questions respecting the constitution of that consciousness of the Great Being supposed to be thus localized. But, preserving our gravity, we have simply to recognize the obvious truth that Humanity has no corporate consciousness whatever. Consciousness, known to each as existing in himself, is ascribed by him to other beings like himself, and, in a measure, to inferior beings; and there is not the slightest reason for supposing that there ever was, is now, or ever will be, any consciousness among men save that which exists in them individually. If, then, "the Great Being, who is the Author of all these conquests," is unconscious, the emotions of veneration and gratitude are absolutely irrelevant.

It will doubtless seem a paradox to say that human evolution with all its marvels, is to be credited neither to Humanity as an aggregate, nor to its component individuals; but the paradox will not be difficult to justify: especially if we set out with some analogies. An apt one is supplied by that "thing of beauty," the *Euplectella* or "Venus' flower-basket," now not uncommon as a drawing-room ornament. This fragile piece of animal architecture is not a product of any conscious creature, or of any combination of conscious creatures. It is the framework unknowingly elaborated by innumerable ciliated monads—each a simple nucleated cell, with a whip-like appendage which serves, by its waving movements, to aid the drawing in and sending out of sea-water, from which nutritive matter is obtained; and it is simply by the proclivities which these monads have toward certain modes of growth and secretion, that they form, without the consciousness of any one, or of all, this complicated city they inhabit. Again, take the case of a coral island. By it we are shown that a multitude of insignificant individuals may, by their separate actions carried on without concert, generate a structure imposing by its size and stability. One of these palm-covered atolls standing up out of vast depths in the Pacific, has been slowly built up by coral-polyps, while, through successive small stages, the ocean-bottom has subsided. The mass produced by these brainless and almost nerveless animals—each by its tentacles slowly drawing in such food as the water occasionally brings, and at intervals budding out, plant-like, a new individual—is a mass exceeding in vastness any built by men, and defies the waves in a way which their best breakwaters fail to do: the whole structure being entirely undesigned, and, indeed, absolutely unknown to its producers, individually or in their aggregate.

Prepared by these analogies, every one will see what is meant by the paradox that civilization, whether contemplated in its great organized societies or in their material and mental products, can be credited neither to any ideal "Great Being Humanity," nor to the real beings summed up under that abstract name. Though we can not in this case say that neither the aggregate nor its units have had any consciousness of the results wrought out, yet we may say that only after considerable advances of civilization, has this consciousness existed on the part of a few. Communities have grown and organized themselves through the attainment of private ends, mostly pursued with entire selfishness, and in utter ignorance of any social effects produced. If we begin with those early stages in which, among hostile tribes, one more numerous or better led than the rest, conquers them, and, consolidating them into a larger society, at the same time stops inter-tribal wars; we are shown that this step in advance is made, not only without thought of any advantage to Humanity, but often under the promptings of the basest motives in the mind of the most atrocious savage. And so onward. It needs but to glance at such wall-paintings as those of the conquering Rameses at Karnac, or to read the inscriptions in which Assyrian kings proudly narrated their great deeds, to see that personal ambitions were pursued with absolute disregard of human welfare. But for that admiration of military glory with which classical culture imbues each rising generation, it would be felt that whatever benefits these kings unknowingly wrought, their self-praising records have brought them not much more honor than has been brought to the Fijian king Tanoa by the row of nine hundred stones recording the number of victims he devoured. And though the outcome of those struggles for supremacy in which, during European history, so many millions have been sacrificed, has been the formation of great nations fitted for the highest types of structure; yet when, hereafter, opinion is no longer swayed by public-school ethics, it will be seen that the men who effected these unions did so from desires which should class them with criminals rather than with the benefactors of mankind. With governmental organizations it was the same as with social consolidations: they arose not to secure the blessings of order, but to maintain the ruler's power. As the original motive for preventing quarrels among soldiers was that the army might not be rendered inefficient before the enemy, so, throughout the militant society at large, the motive for suppressing conflicts was partly that of preventing hindrance to the king's wars, and partly that of asserting his authority. Administration of justice, as we know it, grew up incidentally; and began with bribing the ruling man to interfere on behalf of the complainant. Not wishes for the public weal, but wishes for private profit and power, originated the regulative organizations of societies. So has it been, too, with their industrial organizations. Acts of barter between primitive men were not prompted by thoughts of benefits to Humanity, to be eventually achieved by division of labor. When, as among various peoples, on occasions of assembling to make sacrifices at sacred places, some of the devotees took with them commodities likely to be wanted by others who would be there, and from whom needful supplies could be got in exchange, they never dreamed that they were making the first steps toward establishment of fairs, and eventually of markets: purely selfish desires prompted them. Nor on the part of the peddlers who, supplying themselves wholesale at these gatherings, traveled about selling retail, was there any beneficent intention of initiating that vast and elaborate distributing system which now exists. Neither they nor any men of their time had imagined such a system. And the like holds of improved arts, of inventions, and, in large measure, of discoveries. It was not philanthropy which prompted the clearing of wild lands for the purpose of growing food; it was not philanthropy which little by little improved the breeds of animals, and adapted them to human use; it was not philanthropy which in the course of time changed the primitive plow into the finished modern plow. Wishes for private satisfactions were the exclusive stimuli. The successive patents taken out by Watt, and his lawsuits in defense of them, show that though he doubtless foresaw some of the benefits which the steam-engine would confer on mankind, yet foresight of these was not the prime mover of his acts. The long concealment of the method of fluxions by Newton, as well as the Newton-Leibnitz controversy which subsequently arose, show us that while there was perception of the benefits to science, and indirectly to Humanity, from the discoveries made by these mathematicians, yet that desires to confer these benefits were secondary to other desires—largely the love of scientific exploration itself, and, in a considerable degree, "the last infirmity of noble minds." Nor has it been otherwise with literature. Entirely dissenting, though I do, from the dictum of Johnson, that "No man but a blockhead ever wrote except for money," and knowing perfectly well that many books have been written by others than "blockheads," not only without expectation of profit, but with the certainty of loss; yet I hold it clear that the majority of authors do not differ from other men to the extent that the desire to confer public benefit predominates over the desire to reap private benefit; in the shape of satisfied ambition if not in the shape of pecuniary return. And it is the same with the delights given to mankind by artistic products. The mind of the artist, whether composer, painter, or sculptor, has always been in a much greater degree occupied by the pleasure of creation and the thoughts of reward, material or mental, than by the wish to add to men's gratifications.

But we are most clearly shown how little either any aims of an ideal "Great Being," or any philanthropic aims of individuals, have had to do with civilization, by an instance which M. Comte himself refers to as proving our indebtedness. He says: "Language alone might suffice to recall to the mind of every one how completely every creation of man, is the result of a vast combination of efforts, equally extended over time and space." * Now nothing is more manifest than that language has been produced neither by the conscious efforts of the imagined "Great Being, who is the Author of all these conquests," nor by the conscious efforts of individual men. Passing over that intentional coining of words which occurs during the later stages of linguistic progress, it is undeniable that during those earlier stages which gave to languages their essential structures and vocabularies, the evolutionary process went on without the intention of those who were instrumental to it. The man who first, when discussing a probability, said *give* (i. e. grant, or admit), so-and-so, and such and such follows, had no idea that by his metaphorical *give* (which became *gif* and then *if*) he was helping to initiate a grammatical form. The original application of the word *orange* to some object like an orange in color, was made without consciousness that the act would presently lead to enrichment of the language by an additional adjective. And so throughout. The minute additions and modifications which have, in thousands of years, given to human speech its present perfection, arose as random changes without thought of improvement; and the good ones insensibly spread as serving better the purposes of those who adopted them.

Thus, accepting M. Comte's typical instance of the obligations under which Humanity during the past has placed individuals at present, we must say that language, having been evolved during men's intercourse without the least design on their parts of conferring benefits, and without the faintest consciousness of what they were doing, affords no reason whatever for regarding them with that "veneration and gratitude" which he thinks due.

"But surely 'veneration and gratitude' are due somewhere. Surely civilized society, with its complex arrangements and involved processes, its multitudinous material products and almost magical instruments, its language, science, literature, art, must be credited to some agency or other. If the 'Great Being, Humanity,' considered as a whole, has not created it for us—if the individuals who have co-operated in producing it have done so while pursuing their private ends,

* "Positive Polity," vol. ii, p. 48.

mostly without consciousness that they were either furthering or hindering human progress, how happens it that such benefits have been achieved, and to what shall we attribute achievement of them?"

To Mr. Harrison, if his allegiance to his master is unqualified, no answer which he will think satisfactory can be given; for M. Comte negatives the recognition of any cause for the existence of human beings and the "Great Being" composed of them. It was one of his strange inconsistencies that, though he held it legitimate to inquire into the evolution of the Solar System (as is shown by his acceptance of the nebular hypothesis), and though he treats of human society as a product of evolution, yet all that region lying between the formation of planets and the origin of primitive man, was interdicted by him. To those, however, who accept the doctrine of organic evolution, either with or without the doctrine of evolution at large, the obvious answer to the above question will be that if "veneration and gratitude" are due at all, they are due to that Ultimate Cause from which Humanity, individually and as a whole, in common with all other things, has proceeded. There is nothing in embodied Humanity but what results from the properties of its units—properties mainly prehistoric, and in a small measure generated by social life. If we ask whence come these properties—these structures and functions, bodily and mental—we must go for our answer to the slow operation of those processes of modification and complication through which, with the aid of surrounding conditions, ever themselves growing more involved, there have been produced the multitudinous organic types, up to the highest. If we persist in putting question beyond question, we are carried back to those more general causes which determined the structure and composition of the Earth during its concentration; and eventually we are carried back to the nebulous mass in which there existed, undistinguished into those concrete forms we now know, the forces out of which all things contained in the Solar System have come, and in which there must have been, as Professor Tyndall expresses it, "the promise and potency of all terrestrial life." Whether we contemplate such external changes as those of stars moving ten miles per second, and those which now in hours, now in years, now in centuries, arrange molecules into a crystal; or whether we contemplate internal changes, arising in us as ideas and feelings, and arising also in the chick which but a few weeks since was a viscid yelk, we are compelled to recognize everywhere an Energy capable of all forms and which has been ever assuming new forms, from the remotest time to which science carries us back down to the passing moment. If we take the highest product of evolution, civilized human society, and ask to what agency all its marvels must be credited, the inevitable answer is—To that Unknown Cause of which the entire Cosmos is a manifestation.

A spectator who, seeing a bubble floating on a great river, had his attention so absorbed by the bubble that he ignored the river—nay, even ridiculed any one who thought that the river out of which the bubble arose and into which it would presently elapse, deserved recognition, would fitly typify a disciple of M. Comte, who, centering all his higher sentiments on Humanity, holds it absurd to let either thought or feeling be occupied with that great stream of Creative Power, unlimited in Space or in Time, of which Humanity is a transitory product. Even if, instead of being the dull leaden-hued thing it is, the bubble Humanity had reached that stage of iridescence of which, happily, a high sample of man or woman sometimes shows us a beginning, it would still owe whatever there was in it of beauty to that Infinite and Eternal Energy out of which Humanity has quite recently emerged, and into which it must, in course of time, subside. As with thousands of lower types of creatures which have severally illustrated the truth that the life and death of the individual prefigure in brief space the life and death of the race, so with this highest type of creature, Man: a beginning and end to Humanity are no less certain than the beginning and end to each human being. And to suppose that this relatively-evanescent form of existence ought to occupy our minds so exclusively as to leave no space for a consciousness of that Ultimate Existence of which it is but one form out of multitudes —an Ultimate Existence which was manifested in infinitely-varied ways before Humanity arose, and will be manifested in infinitely-varied other ways when Humanity has ceased to be, seems very strange —to me, indeed, amazing.

And here this contrast between the positivist view and my own view, equally marked now as it was at first, leads me to ask in what respects the criticisms passed on the article—"Religion: a Retrospect and Prospect" have affected its argument. Many years ago, as also by implication in that article, I contended that while Science shows that we can know phenomena only, its arguments involve no denial of an Existence beyond phenomena. In common with leading scientific men whose opinions are known to me, I hold that it does not bring us to an ultimate negation, as the presentations of my view made by Mr. Harrison and Sir James Stephen imply; and they have done nothing to show that its outcome is negative. Contrariwise, the thesis many years ago maintained by me against thinkers classed as orthodox,* and reasserted after this long interval, is that though the nature of the Reality transcending appearances can not be known, yet that its existence is necessarily implied by all we do know—that though no conception of this Reality can be framed by us, yet that an indestructible consciousness of it is the very basis of our intelligence; † and I do not find, either in Mr. Harrison's criticisms or in those of Sir James Stephen, any endeavor to prove the untruth of this thesis. More-

* "First Principles," § 26.

† Sir James Stephen, who appears perplexed by the distinction between a conception and a consciousness, will find an explanation of it in "First Principles," § 26.

over, as originally elaborated and as recently restated, my argument was that in the discovery by Science that it could not do more than ascertain the order among phenomena, there was involved a tacit confession of impotence in presence of the Mystery of Things—a confession which brought Science into sympathy with Religion; and that in their joint recognition of an Unknowable Cause for all the effects constituting the knowable world, Religion and Science would reach a truth common to the two. I do not see that anything said by my critics has shaken this position. I held at the outset, and continue to hold, that this Inscrutable Existence which Science, in the last resort, is compelled to recognize as unreached by its deepest analyses of matter, motion, thought, and feeling, stands toward our general conception of things, in substantially the same relation as does the Creative Power asserted by Theology; and that when Theology, which has already dropped many of the anthropomorphic traits ascribed, eventually drops the last of them, the foundation-beliefs of the two must become identical. So far as I see, no endeavor has been made to show that this is not the case. Further I have contended, originally and in the article named, that this Reality transcending appearance (which is not simply unknown as Mr. Harrison thinks it should be called, but is proved by analysis of the form of our intelligence to be unknowable),* standing toward the Universe and toward ourselves in the same relation as an anthropomorphic Creator was supposed to stand, bears a like relation with it not only to human thought but to human feeling: the gradual replacement of a Power allied to humanity in certain traits, by a Power which we can not say is thus allied, leaves unchanged certain of the sentiments comprehended under the name religious. Though I have argued that in ascribing to the Unknowable Cause of things such human attributes as emotion, will, and intelligence, we are using words which, when thus applied, have no corresponding ideas; yet I have also argued that we are just as much debarred from denying as we are from affirming such attributes;† since, as ultimate analysis brings us everywhere to alternative impossibilities of thought, we are shown that beyond the phenomenal order of things, our ideas of possible and impossible are irrelevant. Nothing has been said which requires me to change this view: neither Mr. Harrison's statement that "to make a religion out of the Unknowable is far more extravagant than to make it out of the Equator," nor Sir James Stephen's description of the Unknowable as "like a gigantic soap-bubble not burst but blown thinner and thinner till it has become absolutely imperceptible," seems to me applicable. One who says that because the Infinite and Eternal Energy from which all things proceed, can not in any way be brought within the limits of human consciousness it therefore approaches to a nonentity, seems to me like one who says of a vast number that because it passes all possibility of

* "First Principles," Part I, chapter iv.

† "First Principles," § 31.

enumeration it is like nothing, which is also innumerable. Once more when implying that the Infinite and Eternal Energy manifested alike within us and without us, and to which we must ascribe not only the manifestations themselves but the law of their order, will hereafter continue to be, under its transfigured form, an object of religious sentiment; I have implied that whatever components of this sentiment disappear, there must ever survive those which are appropriate to the consciousness of a Mystery that can not be fathomed and a Power that is omnipresent. Mr. Harrison and Sir James Stephen have said nothing to invalidate this position. Lastly, let me point out that I am not concerned to show what effect religious sentiment, as hereafter thus modified, will have as a moral agent; though Mr. Harrison, by ridiculing the supposition that it will make good men and women, seems to imply that I have argued, or am bound to argue, that it will do this. If he will refer to the "Data of Ethics" and other books of mine, he will find that modification of human nature, past and future, I ascribe in the main to the continuous operation of surrounding social conditions and entailed habits of life; though past forms of the religious consciousness have exercised, and future forms will I believe exercise, co-operative influences.*

How, then, does the case stand? Under "Retrospect," I aimed to show how the religious consciousness arose; and under "Prospect" what *of this consciousness* must remain when criticism has done its utmost. My opponents would have succeeded had they shown (1) that it did not arise as alleged; or (2) that some other consciousness would remain; or (3) that no consciousness would remain. They have done none of these things. Looking at the general results, it seems to me that while the things I have said have not been disproved, the things which have been disproved are things I have not said.

SOME RAMBLES OF A NATURALIST.†

By CHARLES C. ABBOTT, M. D.

WHEN I happen out for a stroll, the difficulty that besets me is not what to seek—for to ramble without an object is an abomination—but what to choose of the endless variety of objects worthy of attention. I do not like to determine this after I have started, but prefer saying to myself, "I will watch the birds to-day," or, "I will hunt up the meadow-mice." To do this at once gives an additional interest to a contemplated ramble; and, in all my experience, I have

* "Data of Ethics," § 62.

† From the author's "Rambles about Home," in the press of D. Appleton & Co.

never yet failed to find some trace, at least, of that object to observe which I took the walk.

Whenever I have seen a mink in my meadow-rambles, I have been impressed with the fact that all animals that fear man are as much on the lookout for him, and try as sedulously to avoid him, as they do any of their natural enemies. If they do so, is it at all strange that we so seldom see them when we go bungling about their haunts? We probably never take a walk in the woods that we are not watched by many creatures which we do not see; and many a squeak or whistle which, if heard at all, is attributed to some bird, is a signal-cry of danger made by some one animal which, having seen us, takes this method of warning its fellows. I have more than once tested this in the case of the mink. Mooring my boat near where I had reason to believe these animals had their nests, and remaining perfectly quiet and in hiding, I have usually been rewarded by seeing the minks moving about as soon as their confidence was restored by the absence of all signs of life in or about the boat. They would come out of their burrows, or from under large roots, and dive into the water, or it might be that they carried a mussel from the shore to their retreat.

Any act of this kind, free from the restraint of fear, is in the case of all animals the most interesting and instructive, and, were our opportunities of this kind more frequent, our knowledge of animal life would soon be largely increased.

During the spring and summer of 1874 especially, and at all favorable opportunities since, my out-door studies were largely confined to particular phases of bird-life, rather than to their habits generally. Most prominent among these was that of singing, and its relation to the other utterances of birds, for I had been long under the impression, and since am fully convinced, that a bird's song bears just the same relationship to its various chirps, twitters, and calls, that singing with mankind bears to ordinary conversation. Careful observation will enable any one to see clearly that every bird has a considerable range of utterance. Observe two birds immediately after mating, and what a laughable caricature of a newly-married couple—say on their wedding-journey—are their actions and their low, ceaseless twittering! They also have their petty vexations and their little quarrels, in which the feminine voice is ever the louder and more rapid in its utterance, and its owner enjoys the precious privilege of the last word.

But it may be urged that to constitute language, or something akin to it, these chirps and twitters must be shown to convey ideas. Can one bird tell another anything? it will be asked. To this I answer that, if any one has watched a colony of brooding krakles, or paid close attention to a flock of crows, he has probably satisfied himself upon this point. Crows have twenty-seven distinct cries, calls, or utterances, each readily distinguishable from the other, and each having an unmistakable connection with a certain class of actions; some of which, as, for instance, the many different notes of the brooding-birds, are only heard at certain seasons. In this connection, it may be added that the intelligence of crows is fully one half greater than that of any other bird in our fauna. Instances of the exercise of much cunning and forethought on their part are almost innumerable.

Let us see, however, if among our singing-birds there is not to be found evidence of an ability to communicate ideas, presumably by the aid of vocal sounds. Here is an occurrence that took place in my presence in the spring of 1872. A pair of cat-birds were noticed carrying materials for a nest to a patch of blackberry-briers hard by. To test their ingenuity, I took a long, narrow strip of muslin, too long for one bird to carry conveniently, and placed it on the ground in a position to be seen by the birds when searching for suitable materials for their nests. In a few moments one of the cat-birds spied the strip and endeavored to carry it off, but its length and weight, in whichever way the bird took hold of it, and he tried many, impeded its flight. After worrying over it for some time the bird flew off, not, as I supposed, to seek other materials, but, as it proved, to obtain assistance in transporting the strip of muslin in question. In a few moments it returned with its mate, and then, standing near the strip, they held what I consider to have been a consultation. The chirping, twittering, murmuring, and occasional ejaculations were all unmistakable. In a few moments this chattering, if you will, ceased, and the work commenced. Each took hold of the strip of muslin at about the same distance from the ends, and, starting exactly together, they flew toward their unfinished nest, bearing the prize successfully away.

I followed them as quickly as possible, and, reaching the brier-patch, never before or since heard such an interminable wrangling and jabbering. Had I not seen the birds, I doubt if I should have recognized them from their voices. The poor birds simply could not agree how to use so long a piece of material to the best advantage. If it had been shorter, they might have made it serviceable; but as it was, being neither willing to discard it nor able to agree as to its proper use, they finally abandoned it altogether, and so too they did the unfinished nest and the neighborhood.

In one corner of a low-lying tract near my house, called the "mucky meadow," there remains a clump of large maples, pin-oaks, and birches which have somehow been spared by the former owners of the land. They are mine now and are safe. At the first white frost, the hollow maple, that throughout the summer has securely housed a family of short-eared owls, now gives us evidence of the fact, by dropping the leafy screen that hid them well from view. While the young were yet babies the old tree shielded them well—now they are able to shift for themselves, and the tree offers them shelter, but nothing more. With the departure of the sunlight the owls are all astir, and it is funny enough to see them. Of a single owl but little can be said; but before the family separates, and while the young are receiving their lessons in mouse-hunting, it becomes very evident, first, that owls are great talkers; and, secondly, that they are decidedly intelligent. I was impressed with these facts during a pleasant moonlight evening last October, when, having taken my stand to watch the owls, I saw the whole family of six as they came from their nest in the tree. The old birds first appeared, flew directly toward the meadow, and disappeared in the long grass. Soon the four young birds made their appearance, but only to creep cautiously along the limbs of the tree, and then settle themselves, in a lazy, muffled-up manner, as though nothing remained to be done. All the while the old birds kept up a peculiar call—more like a scream than a hoot—not altogether unpleasant to the ear. I am in doubt whether the young owls made any reply, though I took a faint clicking noise to be such. In a little while, however, they began to get hungry, and then they uttered unmistakable cries, to which the parent owls replied by returning to the tree. In the beak of each owl was a mouse, or what I took to be such, and when they alighted on the maple I could detect, in the uncertain light, that they did not approach closely to the young birds, but, having removed the mice, which they now held in their claws, they chattered and screamed to their young, in a manner that could only be interpreted as, "Come over here and get your mouse." It was evident that the young owls were to be taught to help themselves, and to practice their power of flight. As an inducement to do the latter, the mice were held temptingly before them, but quite out of reach. Finally, one young owl, more venturesome than his fellows, essayed to fly; but it was a miserable failure, for, instead of reaching the desired branch, it fell short a foot or more, and tumbled to the ground. I can not prove that owls laugh, but I think any one who heard the old birds just then would never doubt the fact that they do. The funniest feature, however, was that the three remaining young birds were disgusted with what they saw, or were frightened by it—at all events, they hastened back to the nest, and I saw them no more that evening.

Of the poor fellow that fell to the ground there is much to be said, as it was with it that the old birds were now wholly concerned, and their actions were highly entertaining. Leaving the tree, they flew down to the hapless bird, and muttered in low tones to it, in a most sympathizing manner. Their utterances now, which I could hear notwithstanding the racket made by the frogs, were very varied, and gave the impression that they were holding a conversation. After the lapse of a minute or more the old birds together took a short, low flight, and then returned to the young owl. Was it not to show it how easy flight was? Then again they flew away, in the same manner, and the young owl endeavored to follow. It was with evident difficulty that it left the ground, but when once its feet were clear of the grass it progressed satisfactorily, though only for a short distance. This pleased the old birds, for one of them came to the plucky little fellow, and, with one wing extended, patted the young bird on the head and back most tenderly. At this I laughed aloud, most unfortunately, and immediately the old birds flew to the nesting-tree, and then discovered my hiding-place. Of all the scoldings I ever got, that from the owls, this evening, was the severest. As I moved away I recalled the oft-witnessed scene of the king-birds worrying crows. It was the same thing in my case. Keeping just out of reach of my cane, they swooped about my head and snapped their bills viciously. They did not dare to strike me, but they came unpleasantly near, and it was with a feeling of comfort that I finally reached safer quarters.

A chance conversation discovered to me one companion of many of my walks. When a mere boy, Uz Gaunt lived in this neighborhood, having a little cottage adjoining my grandfather's woods, and he, above all others, gave me my first lesson in practical zoölogy. Of the stories which he would tell when he was in the humor, the following talk about turtles is a specimen:

"Christmas of '77 was a green one, you may remember," remarked Uz, as he shook the ashes from his pipe. "It didn't need any hickory-logs blazin' on the hearth, such as these," and he stirred the ashes and rearranged the wood on the andirons as he spoke of them. "The weather had been mild for a long time, and once I heard frogs singin'. Well, this kind of thing sort of came to a focus on Christmas-day, which was warm even in the shade. The river was low, the meadows dry, and the crows as noisy as in April. I felt sort of restless-like, and took a walk in the meadows. I left my gun home, and thought I'd just look 'round. Without thinking of them when I started out, I wandered over to your marshy meadow, and began pokin' about with my cane for snappers. You know I take kindly to a bowl of snapper-soup of my own fixin'."

"Yes, I do that, and can run along neck-and-neck with you, when you're the cook."

"Well, I followed the main ditch down, jumpin' from hassock to hassock, and kept probin' in the mud with my cane, when, after a bit, I felt something hard at the end of my stick. It wasn't a stone or a stump, I knew at once. There was a little tremble run up the stick to my hand that told me that much—a sort of shake, as though you hit an empty barrel, as near as I can tell you. I'd a turtle down in the mud, and concluded to bring it out into the daylight. There's more than one way to do this, but none of 'em is an easy job to get through with. I kept probin' 'round him, to try and make out where his head was, and then I could feel for his tail, and pull him out. Now this does very well for one of your common snappers, but didn't work so easy in this case. I could sort of feel that turtle all over the meadow.

Wherever I put my cane down, I seemed to come to his back shell; but after edgin' out a bit for some time I could make out the rim of it, and I tell you he was a whopper, accordin' to my probin'. That turtle seemed about as big 'round as a wash-tub, and I got regularly worked up about him. I wasn't in trim for huntin', but didn't care. I'd found a turtle that was worth havin', and I meant to have him. Probin' showed that he was about three feet deep in the mud, but I made up my mind to locate his tail and then reach down for him. So I did, but it was no use. I felt about, and got one ugly scratch from a hind-foot, but he kept his tail out of reach, or hadn't any; I didn't know which, then. After thinkin' a spell, I concluded I'd try to get a pry under him, and went for a fence-rail. It took me some time to get what I wanted, and when I got back that turtle had got out. I probed all 'round, but he'd moved. This rather took me down, but I kept up my hunt, and after a bit found he'd moved straight for the main ditch, and was tearin' up the mud on the bottom as he went. This was all that saved him for me, and I no sooner learned his whereabouts than I went for him in earnest. I ran the rail I had right under him, and tried to lift him up. Thunder and lightnin', boy, you might as well try to lift a steer! I disturbed him, though, and checked his course a bit. Jammin' the rail down again, I guess I hit his head, for it riled him, evidently, and he raised right up. His head and neck came out of the sand, and I was for standin' back just then. If ever you saw a wicked eye, that turtle had one, and his head was as big as my fist. Stickin' his head out, though, gave me the knowledge I wanted. I knew how he laid in the mud, and I ran my rail down under him as far as I could. It kept him from divin' down, and I went right into the ditch to try and get a hold on his tail if I could. This I did, after feelin' for it a bit, and no sooner had I got a good grip on it than the old fellow got free of the rail and commenced goin' deep into the mud. I tugged and he dug, and it was a clear case of 'pull Dick, pull devil,' between us. He was gettin' the better of me, though, for I was gettin' chilled in that water, and had nearly lost my hold, when the turtle gave an extra jerk, and if it hadn't been for the fence-rail I'd a lost him. I was pulled for'ard, but the rail was right in front, so I put one foot on it, to keep from sinkin' any deeper in the mire. This bracin' gave me the advantage now, and I put all my strength to it. The turtle came a little, and I seemed to gain strength. I tugged and tugged with all my might, and presently his hind-feet showed. You see, he hadn't firm enough mud to hold on to. I backed slowly across the ditch when I got him in open water, and got a fair footin' on the ditch-bank at last. Still, I wasn't out of the woods by a long shot. That turtle weighed close onto seventy pounds, and I'd no means of handlin' him. Chilled through, with both hands needed to hold him, and in the middle of the mucky meadow, all that was left me was to try and drag him to the high, smooth meadows. It was a tough job, I tell you. I had to walk backward, and he pulled against me like a frightened horse. I gained a little, slowly, and after a bit got on the high ground. Then I felt more at ease and took a rest. I couldn't take him home, of course, in the same fashion, but I had a chance to let him loose, and rest my hands. How I looked 'round for a bit of rope to bridle him! It was no use, though, and after all I was likely to lose him altogether. After a minute's thinkin', it occurred to me I'd make a hobble out of my shirt and then slip home lively for the right sort of tackle. I wasn't long in gettin' the shirt off, and I twisted it into a sort of rope and hobbled him with it. It was a desperate, odd-lookin' turtle when I got through, and I laughed at him a bit as I turned toward the house. You see, I left him on his back, and his legs bound so he couldn't use 'em to turn over. I skipped pretty lively, I tell you, for that mile or so twixt me and home, and was in a good glow when I got in. Hettie looked kind o' scared when she saw me, but I put her mind to rest in two words, and soon was on my way back. A bit of rope and my sheath-knife was all I needed. I skipped over the fields pretty lively, and was soon again in sight. Now, I don't think it was an hour, by some minutes, before I was back on the high meadow, but, by gracious! it don't take long for scenes to change in natur' any more than it does in a theatre. Of all queer sights, that was the funniest I saw when I got back. The turtle had got half free of my old red shirt, and was pawin' the air like mad, tryin' to get on his feet again. I could see that much a long way off, and put on extra speed; but when I was about fifty yards off I stopped short. There was that turtle wrapped in my shirt, and a pesky skunk sort of standin' guard over him. Now, I hate skunks! They don't pay to trap, and they rob my hen-roost every winter. I was afraid to frighten him, too, for fear he'd spoil my snapper, and I wanted the value of a shirt out of the turtle, if nothin' more. I walked a bit nearer, to make sure of how matters stood, and it was clear as day, the skunk thought he had a good thing of it, if he could only kill that snapper. I thought the same way, and didn't want to be bettered by a pesky skunk. I made up my mind to jockey about it, a little; and so, first, heaved a stone at the critter. It gave me a look and started on a slow trot, but it was all up with me, sure enough. He shook that thunderin' old brush right at the turtle and—well! if he didn't sicken the snapper, he did me, that's certain. I stood the racket a bit, though, and tried to move the snapper, but it was no use; I couldn't keep at it long enough to do anything, and don't believe it would have amounted to much anyhow. I got a stick and put the snapper on his feet, as well as I could, without touchin' him, and he waddled off for the mucky meadow, with most of my shirt still stickin' to him, and plunged into the ditch as soon as he could."

"So you lost the turtle after all," I remarked in a low tone, not feeling sure I had heard the last of the story.

"No I didn't either," Uz replied quickly. "Don't set me down for such a fool as that. I knew well enough the turtle wouldn't wander far, so I kept him in mind, and the next April I went out in proper trim and hunted him up. I found him after two days' huntin', when I got a dozen big ones besides, but he was the king of the lot. He couldn't turn 'round in a wash-tub, and weighed somethin' over seventy pounds. I looked all over him for some sign of my shirt, but there wasn't a thread left."

"How old do you suppose he was?" I asked, when Uz had concluded his story.

"I'm not sure I can say, but he was no chicken, that's certain."

"According to Professor Agassiz, a turtle a foot long is close to fifty years old," I replied.

"Fifty years old! Then my big snapper came out of the ark, I guess," remarked Uz.

SCIENTIFIC PHILANTHROPY.

By LEE J. VANCE, B. S.

THE nature and purpose of our modern philanthropy—indeed, the inquiry whether or not utilitarian or altruistic considerations should inspire and control our actions—constitute an important and most instructive study in sociology. In the article on "Scientific Philanthropy," translated from the "Revue des Deux Mondes," and published in the "Monthly," 1883, this view of the question in its ethical aspect was almost entirely overlooked. The writer, M. Fouillée, has, with much ability, controverted the arguments early advanced by Malthus, but latterly by Darwin, Spencer, and others, who have approached the problem from a purely scientific stand-point. The author invites criticism by stating some conclusions, the validity of which sociologists high in repute are quick to question. And treating of Philanthropy as scientific, he has proposed a subject world-wide in its application and interest; and it is proper that the incorrectness of his conclusions be pointed out in the same Monthly that published them for American readers.

Philanthropy is founded in sentiment, and in the desire on the part of the strong, the favored, and the fortunate, to assure the comfort of the weak, unfavored, and unfortunate. It becomes scientific when those severe and exact logical methods of procedure—the indispensable prerequisites to a thorough knowledge of the preparatory studies of biology and psychology—are used in determining the effects of the laws of physical and moral heredity with natural selection on the increase and movement of population. First, we have to deal with those moral foundations which, as M. Fouillée declares, are of such moment, though so greatly "misconceived" by Mr. Darwin and his partisans. Long before Darwin, Mr. Spencer, in his "Social Statics," inquired: "For what faculty is it, whose work a poor-law so officiously undertakes? Sympathy." Darwin labored under the same misconception, for in the "Descent of Man" he says that the aid we feel impelled to give to the helpless and incompetent is mainly the result of sympathy, originally acquired as part of the social instincts, and subsequently rendered more widely diffused. Thus, the necessary datum of ethics lies in the principle, that each man must recognize and respect the rights and claims of another, equally with his own. It follows, then, that benevolence and justice spring from the same moral sentiment which is the foundation of every form of philanthropy. If the question was one of pure ethics, it would be legitimate to inquire, Ought philanthropy to preserve those who, from a mental and physical point of view, are not fit to be preserved? Is it right that the scanty means of subsistence should be at the command of individuals who, by their own conduct, have no claim for relief? In reply, it may be confessed a delicate task to draw the line of demarkation sharply. The warfare waged in ethics has been at last transferred into the domain of sociology. The two widely different systems of social science—the one treating the topic by utilitarian methods, the other by the way of altruism—is the logical outcome of the rival claims of utility and intuition to be considered the rightful premises in all moral differences. To the one it is objected that self-interest is developed entirely at the expense of natural sympathy; against the latter it is urged that the feelings of sentiment are allowed to control in shaping the policy of public relief, instead of using the slower and more cautious methods of reason. The principle upon which the sentimental school is founded is co-operation, whereby the weak in body or in mind, without struggle, share alike with the more vigorous and prudent. The scientific sociologist starts with the competitive theory of life, whereby in an advancing society, with the agglomeration of population in great centers, it is everywhere seen that industrial virtues are more and more the high rewards of mental and physical vigor, while poverty and pain are the attendant penalties attached to weakness, idleness, and imprudence.

Scientific Philanthropy is based on the intimate scientific connection between biology and sociology, first enunciated by M. Comte; is an attempt on the part of science to control the struggle, not only of man with Nature, but of man with man. Its conscious aim is, therefore, to overcome the harsh and rigorous effects of certain known biological laws. With successive differentiations of individual functions and pursuits there comes an increasing specialization of each differentiated member of society, and hence industrial virtues or vices which the parent fixes for the child by heredity leads to the existence of two very different classes in the community—the rich and the poor, the strong and the weak, the rulers and the ruled. As population becomes denser and denser, the contrast between the classes becomes still more marked, and we find in the cities poverty, hardship, and suffering, face to face with wealth, luxury, and ease. This is, in truth, the social problem. The sympathetic party, who regard this state of things in society as unjust and wrong, because unequal, invoke the assistance of Government, in State education, in public institutions, and in State Boards of Charities. The question may be stated thus: Does scientific philanthropy render the vital competition between man and man more *unequal?* Or, as a question for the legist, it becomes: *What public duty of relief does the State owe to its citizens?* It seems to us that these questions constitute the problem of philanthropy in its widest significance, and no apology is needed for treating them in detail.

M. Fouillée has fallen into the common error of supposing Malthus a determined enemy of all charity, quite overlooking the fact that he has devoted a most appreciative chapter to "the direction" of our benevolence (Bk. IV, chapter ix). As currently reported, the Malthusian theory would exclude all notion of public relief. Pushed to the extreme, it asserts that when the improvident bring into the world human beings for whom there is no subsistence, then we should leave to Nature, and not to man, the duty of dealing with the surplus of individuals. The Government should not step in and provide for the foolish improvidence of the father. To do so would only act as an encouragement to the lower classes to multiply at a faster rate than the better members of society. Moreover, it is quite irreligious to suppose a good Creator would in this way increase the miseries and privations of life. It is His justice to cut off those who have not "the slightest right to any share in the existing store of the necessaries of life."

Malthus aptly illustrates that all men are Nature's guests; but some are entitled to partake of the viands, while others stand uninvited, no covers being laid for them "at the great banquet of Nature." Here Philanthropy interposes and asks what right have the first guests at a *free* banquet, after they are filled, to keep others from coming for their share? In the struggle for seats at Nature's banquet, shall the strong and vigorous turn back the chairs, and refuse to let the weak partake? Philanthropy insists that there is plenty of room at Nature's table, and that all men shall participate in a feast where priority gives no one any exclusive right. *Vita sedat, uti conviva satur.*

These arguments seem at first glance unpitying, especially to tender-hearted people, who deplore the harsh manner in which Nature punishes ignorance and incompetency as rigorously as froward disobedience. M. Fouillée is indignant over the effort of Malthus to show us the justice of Nature's discipline, whereby in the poverty of the incapable, in the suffering of the imprudent, and in the early death of the intemperate and unhealthy, there is a far-sighted benevolence. He declares that, in order to escape the objections of moralists, and to solve the question of public relief, Malthus had "recourse to Nature, which knows neither pity nor justice; he should have appealed to the reason and freedom of man." While the accusation is not an eminently just one, yet it showed a profound misapprehension of the real nature and purpose of our modern philanthropy. The conscious aim of scientific Philanthropy is, in the first place, to deal with the struggle of man with Nature—is to help men to help themselves; secondly, its aim is to regulate the struggle of man with man—is to help men to understand and adapt themselves to the conditions of existence. It is commonly noticed that the individual who succeeds in his struggle with Nature is apt to be successful in the good-natured struggle with his fellow-men. As Darwin proves, the intemperate suffer from a high rate of mortality, and the extremely profligate leave few offspring. There is economy in this process of elimination, whereby the transmission of the industrial vices is restricted, and, in the competition of life, the degraded members of society, unable to adapt themselves to the conditions imposed by physical and social environment, succumb before the rest of the population. The scientific idea of benevolence involves, first, the preparation of man to receive intelligently Nature's stern discipline—that is, to help him avoid all the evils coming from disobedience of physical agencies, and also to aid him in grasping those great rewards, which, as Huxley says, Nature scatters with as lavish a hand as her penalties. The philanthropist will show us that the hereditary vices which the parent establishes for his children and his children's children meet in the long run with certain punishment. If we could believe in the certainty of punishment, says Sir J. Lubbock, temptation, which is at the root of crime, would be cut away and mankind would become more innocent. The penalties attached to the consumptive, scrofulous, or syphylitic, in contracting marriage, are sharp and sure—ofttimes swift and merciless. Men sin from a mistaken idea of what constitutes to-day's pleasure and to-morrow's pain; and it is not pleasant to be reminded that a great deal of our suffering is due more to ancestral errors than to our own.

There is no possibility of a right understanding of the nature and purpose of Philanthropy without considering the three forces which, by their intricate interaction, combine to make the individual man what he is, natural selection, environment, and heredity. The process of elimination is nothing more nor less than the slow but steady selection of those who give evidence of their better adaptation to those external conditions into which they are born. No matter whether individuals survive, either for their mental or for their physical vigor, these qualities, for which they are selected, once gained and afterward enhanced by increased selection and heredity, become the varied faculties of the men and women of to-day. It is to be observed, in this connection, that any character which helps in any way its possessor is liable to be seized upon, and in terms of sexual selection it may be stated that variations which appear first in either sex early in life are transmitted to both sexes; but variations which appear in either—late in life are transmitted to one sex only. A disease may be sexually limited—as gout, when caused by intemperance during manhood, is developed in the sons in a more striking way than in the daughters. The principle of selection with the survival of the fittest encourages the multiplication of those persons best fitted for the conditions of life, by carrying off the weak and sickly who are least fitted for those conditions; and, if left to work without check, it would result in the slow and steady improvement of the individual faculties and race characteristics, by purifying the blood, invigorating the energies, and strengthening the social instincts. But we civilized men, says Mr. Darwin, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed, and the sick; we institute poor-laws; and our physicians exert their utmost skill to save the life of every patient to the last moment. The effect of the survival of all those who would be eliminated by the principle of selection, together with the rapid rate of increase of the reckless and degraded over the stronger and better members, is to increase the pressure of population on the means of subsistence. This it is which gives rise to the so-called "social problem." Scientific philanthropy is, therefore, the most modern attempt to deal with this problem, which began in primeval times, because of man's rapid multiplication, and which will continue as long as civilization continues.

Mr. Spencer has laid down two propositions which form the basis of M. Fouilleé's article, and also of his attack. They are: "The quality of a society is physically lowered by the artificial preservation of its feeblest members; the quality of society is lowered morally and intellectually by the artificial preservation of those who are least able to take care of themselves." To the first proposition it is objected that Mr. Darwin and his "partisans" exaggerate the harm caused by philanthropy in prolonging the propagation of the weak and helpless; that it applies "only to the infirm properly so called to whom philanthropy is accustomed to give assistance"; that it proves, moreover, too much. In regard to the influence which philanthropy exercises upon the environment, Mr. Darwin's argument may be turned back upon him, says M. Fouillée, and he proposes his theorem—i. e., "the normal conditions most favorable to mankind are to assume the development and selection of a majority of the strong, while saving only a minority of the weak." Such, in their strongest terms, are the arguments brought forward against a truly scientific philanthropy.

Let us examine the exaggerations which the Darwinians are wont to indulge in. If the feeblest members of society are artificially preserved, can they hope to compete on *equal* terms with the strongest members, who would alone have survived? Is it true that the strong and competent are called upon to help the feeble and incompetent, who, by the marriages of the imprudent, would succumb either to competition, or to the action of the environment?

The melancholy Burton said: "A husbandman will sow none but the choicest seed; he will not rear a bull or a horse except he be right shapen in all his parts, or permit him to cover a mare except he be well assured of his breed." He inquires: "*Quanto id diligentius in procreandis liberis observandum?* And how careful, then, should we be in the begetting of our children!" Says Mr. Darwin, man scans with scrupulous care the character and pedigree of his horses and cattle before he matches them, but, when he comes to his own marriage, he rarely, or never, takes any such care. By giving the feeble a better chance to propagate their kind, philanthropy is only filling the world with the "infirm so called, to whom philanthropy is accustomed to give assistance," as well as keeping out the vigorous, who, it is assumed, will give assistance to the feeble members.* The harsh result springing from a misguided benevolence is seen in another way. If we take care of the feeble and helpless, the diseases that appear in their race must be met by new remedies; and new causes of death have arisen from our philanthropic anxiety to suppress former causes of mortality in the feeble. To save and keep alive the weak to-day from injurious influences is to save and keep alive their descendants from totally different influences to-morrow. We suffer from diseases which were quite unknown to our ancestors, of the last century even. The inflammatory and febrile disorders from which they suffered have given place to disorders distinctly American. The neuroses, or nervous diseases, are doubtless intensified by the restless activity which characterizes the social, political, and industrial pursuits of our people; and cerebral difficulties of many forms which appear as types of nervous diathesis developed by our climate and institutions have now become functional.†

It is difficult, therefore, to exaggerate the harm caused by the artificial preservation of the feeblest upon the physical status of future generations. The great harm consists in still further separating classes, and thus creating great inequalities of condition in every society. The artificial preservation of the feeblest is the artificial widening of those lines which Nature draws between one person and another; it gives rise to those natural differences among men which, as Mr. Galton has

* "Descent of Man," 1880, p. 617; *vide* p. 138.

† Compendium Tenth Census, part ii, p. 1665: "The tendency to insanity among the foreign . . . may be accounted for, etc., by the change of climate and of habits of life; by increased anxiety and effort to advance in social respectability, by home-sickness, and in general by removal of props which sustain a man who does not emigrate." Even the same tendency is noticed with native-born who move, "especially from the Atlantic to the Pacific coast."

shown, are greater than many ever suspect. From Rousseau's discourse on the Origin and Grounds of Inequality among Men, down to the writings of Henry George, this condition in society is looked upon as the root of all our social evils. The philosophy of common socialism aims at equality in all things, but fails of realization because men are born unequal in everything. To make out a case against Mr. Darwin and his "partisans," M. Fouillée claims they insist that no deformed or weakly child deserves to survive, but they say, "Woe to the weak!" and "the Spartan method of disposing of feeble children will be that of the perfect sociology." Such an accusation and its utter absurdity deserve hardly passing reproof. Mr. Darwin expressly argues that, if it were intentionally to neglect the weak and helpless, it could only be for a contingent benefit, with an overwhelming present evil. What Mr. Spencer claims, and what is claimed in behalf of scientific philanthropy, is simply to regulate, by healthy and moral modes, the increase of the improvident on the means of subsistence; and this the true philanthropist will do by teaching the laws of health, by right physical education, and by wise sanitary measures. So insalutary are the conditions of the environment of the poor in the cities, that only by fitting themselves to unfavorable conditions is life worth living. This civic population suffer from zymotic diseases due to overcrowding; their drinking-waters, laden with the germs of parasites and fevers, if they do not beget febrile disorders, generate diseases of the liver and spleen; while goitre and thyroid from limestone waters, and pellagra and ophthalmia show themselves at the first favorable opportunity. Poverty always tends to be sickly, because it is continually exposed to the attacks of unhealthy influences. The surroundings during confinement exercise a potent influence upon fœtal nutrition. The Greeks were solicitous in having the female surrounded by symmetrical works of art, but in the upper rooms of the tenement there is no place for the *Lares* and *Penates*.

Philanthropy does not have to deal alone with poverty and improvidence and its attendant evils. To be born rich and feeble is as bad a fate as to be born poor and capable. There is a kind of material success which, when it destroys men's finer moral and intellectual faculties, is a greater curse than the worst kind of hardship. "The chief advantage of poverty as a sanitary or hygienic force," says Dr. Beard, "is that in some natures it inspires the wish and supplies the capacity to escape from it, and in the long struggle we acquire the power and the ambition for something higher and nobler than wealth; the impulse of the rebound sends us farther than we had dreamed." Baron Niebuhr was the first to observe that the wealthy Roman families were short-lived, and perished from the effects of luxury and ease; and the same has been done by Mr. Freeman in English history. The Cæsars, the Valois, the Bourbons, and the English lords, either from vice, idleness, or impotence, were doomed to family extinction. The trials and dangers of childbirth, sterility, incapacity, and nervous disorders, are the coming events which cast their shadows "in the depths of folly and degeneracy." Mr. Galton regrets that he is unable to decide how far men and women who are prodigies of genius are infertile. It would seem, in answer, that where parents have undermined their vitality and their health, by mental or physical overwork, where their activities and powers have been attained at the expense of their physical system, like the most highly cultivated types of vegetable growths, they will beget no germinating seed.

The arguments brought by M. Fouillée against the second part of Mr. Spencer's proposition are of two kinds—the one proposing an altruistic test for benevolent action, the other holding that the law of mental and moral heredity is much "more vague and loose than the law of physical heredity." Let us examine, briefly, the first objection and see what it is worth. Suppose, for example, a man commits a crime, or violates any established law of society; he is punished, either lightly or severely, according to the nature of his act. Conversely, when the intemperate are well aware that hard drinking will cause suffering, and the *blasé* wight knows that his profligacy will produce sickness and disorders, these trangressions are treated with excessive leniency. Paradoxical, then, is the doctrine, held overtly, that the individual who hurts others shall be treated rigorously, but that the individual who hurts himself shall be treated forbearingly. Hence the best specific for vice and crime is the sharp suffering which flows inevitably from vice and crime. Take, also, that distribution of money, "prompted," says Mr. Spencer, "by misinterpretation of the saying that charity covers a multitude of sins." The ignoble action of Evagrius, a Pagan, when he gave his three hundred pieces of gold to the bishop, must be condemned, for he demanded and received a promissory note to be paid in the other world. Take, again, those ostentatious donations by which the donor invites not only present approbation, but bids for posthumous fame and honor; and it is not strange that many eleemosynary institutions intended to perpetuate the bounty of their founders are admired as monuments to personal pride. The elaborate study of Mr. Bain has shown that the love of applause, the feeling of praise, the desire to win the respect of our fellows, even the fear to merit their condemnation, spring from the instinct of *sympathy.* Indeed, sympathy itself is founded upon the instinct of self-preservation; seen alike in that feeling which impels the members of a community to band together for protection, or in that altruism which prompts the strong to help the weak in their burdens. At an early day clover and stramonium were scattered in the fields; and our modern knowledge of poisons, even the invention of dynamite, is due primarily to the instinct of sympathy, though often strangely distorted by fear, malice, or love.

The second part of M. Fouillée's objection is directed toward refuting the theorem that the artificial preservation of those least able to take care of themselves will result in mental and moral deterioration by the operation of heredity. He claims that these biological laws are pushed too far ; that Mr. Spencer's conclusions are still more inadmissible than those of his relative to physical deterioration of society. "If any one denies," Mr. Spencer urges, "that children bear likenesses to their progenitors in character and capacity, if he holds that men, whose parents and grand-parents were habitual criminals, have tendencies as good as those of men whose parents and grand-parents were industrious and upright, he may consistently hold that it matters not from what families in a society the successive generations descend. He may think it just as well if the most active and capable and prudent and conscientious people die without issue, while many children are left by the reckless and dishonest." M. Fouillée does not attempt to refute this conclusion, but denies that it bears against philanthropy itself. Mr. Darwin has brought facts forward to prove that our moral qualities are directly due to our ancestors ; that, for instance, kleptomania or a propensity to lie seemed to run in noble families for several generations, and so could hardly be imputed to any coincidence. The same is equally true of the inheritance of that moral quality called character, which, says M. Ribot, "whether individual or national, is the very complex result of physiological and psychological laws." The bold and vigorous traits of Puritan character were transmitted to their descendants ; they began with this advantage over the other races that emigrated here ; hence the fineness and purity of their mental and moral fiber evolved, of necessity, more swiftly leaders in peace and in war.*

On the other hand, it is argued by M. Fouillée that "the two elements which Mr. Spencer and Mr. Darwin have overlooked—education and just legislation—must be reinstated in the problem. He contends that education abrogates the law of heredity ; that good character will result from good education. It has never been satisfactorily explained why education should be the only cure for crime, poverty, and misery. Huxley says, "If I am a knave or a fool, teaching me to read and write will not make me less of either one or the other, unless somebody shows me how to put my reading and writing to good purposes."† The zealous educationist is too apt to forget that the weak and vicious man is fighting single-handed for the mastery over perhaps a score of evil-minded ancestors. We can make education compulsory, but we can not compel the conscience. To suppose that education will supply those inherited faculties of moral intuition that

* *Vide* "Data of Ethics," 1883, pp. 191, 192; also Mr. Spencer's "American Address."

† That rough moralist, Jack Cade, when he learned that the clerk of Chatham had been setting boys copies, said, "*Here's a villain!*" Also *vide* "Study of Sociology," chapter xv.

are missing—"certain emotions responding to right and wrong"—is parallel with the supposition that the individual may be born again by a kind of mental baptism. The true effect of intellectual training is to clothe heredity with renewed power, giving the children a moral vantage over the parent, and enabling them to leave to their descendants a much further development of the faculties thus fostered, and a still higher power in producing beneficial variations which are a blessing to the race.

It now becomes necessary to inquire, What is the public duty of relief? It will not be disputed that the function of government is to maintain the equal rights of all its citizens; it owes them in the first place justice. When the state undertakes to appropriate annually from the tax-payers millions of dollars for the support of the incapables, it is taking money from the former in no wise for the maintenance of *their* rights. The more the state does for the improvident the less it does for the provident. It is conceded that the right of government to educate the illiterate and to check the vicious is a just one; because it is a duty society owes to itself. The State is under no moral duty to take care of the least of its citizens; but somehow our doctrine of political equality has evolved the socialistic idea of economic equality. Stuart Mill put state aid in this way: The laborer out of work says it is the duty of society to find work for him; but surely it is his duty as a member of that society to find work for every other unemployed man.* As an organized business, with paid executive officers, numerous employés, and bureaus of distribution, modern philanthropy has become a thriving profession. Asylums have been built to keep pace with the increase of the insane; hospitals are founded to meet the constant wants of imbeciles; and almshouses are being erected to accommodate the number of paupers. In this State twenty-five years ago there was one pauper to every one hundred and thirty people, now there is one to every thirty! The charities of the city of New York are something enormous, whether we consider the money spent or the two hundred and fifty charitable organizations. The poor in New York can be born in a public hospital, educated in a public school, clothed and fed in a public reformatory, and doctored in a public dispensary; if they die, it is at public expense they are buried. In a single phrase, metropolitan charity has fully provided for every want from the cradle to the grave.

In the report of the State Board of Charities,† the committee say:

> The pauper, the insane, the deaf-mute, and the blind, appeal to charity; but these juvenile offenders excite both pity for their own condition, and solicitude for their potential influence for evil in society. Some of them show evidence of congenital deformities and defects. . . . It is from the ranks of these that the Communists and Nihilists of the future may be recruited. Whatever may be

* See further, "Political Economy," vol. ii, pp. 590, 591.

† The Fifteenth Report of the State Board of Charities, p. 157.

the theory of punishment for persons of mature years, there can be but one opinion with reference to the duty of the State to these, its wards and weaker members.*

The Department of Charities and Corrections in New York city is controlled by three commissioners, who have under their charge some six hundred employés and about twelve thousand dependents. As is justly complained of in the above official report (see pp. 289–291), the appointment of the commissioners is part and parcel of municipal patronage, and it is declared that the whole tendency of the system is to encourage the increase of pauperism and crime. It is estimated that over seven millions of money are spent annually by public and private organized charity in New York city alone; yet improvidence and dependence remain exactly as the year before. The report of the public charities of that city is a startling document; it shows how much misery is due to a lavish, unsystematic, and misapplied benevolence. In speaking of the money expended by out-door relief societies, to the number of sixty-six, the report says:

> Thus we have an aggregate of $546,832 spent in this kind of charity in New York city during the year 1880; $157,610 of this sum being public money, while about 525,155 cases are reported as having received oneform or another of charitable relief. . . . The foregoing figures, whether we regard them from a financial or humanitarian view, are sufficient to convince us that so important a business as the administration of charity in New York city requires to be carried on on business principles, if the great evils of wasted funds and corrupted and pauperized citizens are to be avoided. Some system is required to enable these various societies to work in harmony. . . . That there is not some such system in New York is a matter of regret . . . to most thoughtful persons who have practical experience, especially as almost all other large cities in this country and in England have proved the value of associated work in diminishing pauperism and poverty in their midst.†

In the interesting report for 1884, the Committee on Out-door Relief say of Kings County, New York, as follows:

> Until 1879 public out-door relief was given by the county to the amount of $100,000, or more yearly; it was then cut off in the middle of winter, without warning, without any substitute being provided, and the result was—nothing. In fact, except for the saving of money, and the stopping of political corruption

* The *proletaires*, though short-lived, intemperate, improvident, and decimated by fever and disease, nevertheless remain the same, continually receiving scores of their own children as recruits to their ranks. It is among the children of this class that the Children's Aid Society has accomplished its work in New York; and according to the report of Mr. Brace, the secretary, for 1883, among the many thousand children sent to the West, with few exceptions, they have grown up to have an honorable standing in the community. It goes to show that hereditary taints may be in part ameliorated by the softening influences of a congenial environment.

† The Fifteenth Report of the State Board of Charities, 1882–'83, p. 322. "Compendium Tenth Census," p. 1665, stated only thirteen out-door poor returns for Boston—a very comfortable income for each for amount of money spent.

carried on by means of relief, and the cessation of the spectacle of hundreds of people with baskets of provisions furnished by the public, it would have been impossible to discover that relief had been stopped. (See pages 8 and 9 of report for 1884.)

The Poor-Law Commission of 1834 * demonstrated beyond controversy the pernicious effects of out-door relief, and it has never been satisfactorily ascertained why the system that was half a century ago condemned and abandoned in England should work with beneficial results in this country. It was with the express purpose of correcting these well-known abuses that the *Charity Organization Society* was established last year in New York city. Its purpose is, as set forth in the official circular, to enlist the co-operation of the charitable societies of the city in establishing a central exchange; to aid the deserving poor in securing employment; and to relieve actual want. Secondly, it will disburse the funds of the giver in a systematic manner so as to prevent imposture. In the past, fraudulent begging was as well organized as the relief sought, and it was often found that the same person was getting aid from half a dozen different societies at one time.†

From the statements already mentioned, it follows that modern Philanthropy has been a great waste of money, effort, and sympathy—has been the means of diffusing habits of improvidence, idleness, and servility in the poorer classes. To aid the good-for-nothings to multiply, says Mr. Spencer, is the same as maliciously providing for our descendants a multitude of enemies. There is, however, a peculiar tendency among certain sociologists to exaggerate the present evils of society, either overlooking or neglecting those of the past and future. The novelist, the *littérateur*, and the *doctrinaire* find plenty of facts at hand to prove the enormous increase of human wretchedness. When social evils are prominently before the people, these persons either rush off to the Legislature to have a new law passed, or they get together a score of individuals and form a new charitable Association. There is a blind and unthinking faith in the paternal functions of the State; as if the social structure was founded upon the *régime* of status, instead of contract, express or implied. All modern relief has proceeded upon the ground that it is the duty of those who have supported themselves to support others, and the good citizen is obliged to shoulder the burdens of the good-for-nothing in addition to his own. If Quashie is idle or incapable of work, the State may say, on the basis of status, "I will feed and clothe you until you find work." Still better

* Poor-Law Commissioners' Report, p. 280.

† Reference is here made to the circular lately issued. The society intends to study the advisability of a system of loans, a bureau of legal relief, the formation of wood-yards to encourage the able-bodied, the labor markets of the United States, and the cost of transportation. The regret expressed on page 322, State Charities Report, is now, in a measure, met.

it would be to give him employment instead of taking care of him. All modern philanthropic legislation has relied upon palliatives; it has undoubtedly ameliorated the near effects of poverty, but unquestionably it has failed to remove its remote causes. We must believe that these social evils of pauperism and crime are incurable, or that the treatment of them is wrong and pernicious.

The latter conclusion leads us all the more to the firm belief that Philanthropy should be established upon a definite and exact scientific basis. In his address before the Academy, in 1880, Victor Sardou said that sympathy impelled men to apply a remedy before they ascertained the cause of the disease—to trust in the efficacy of panaceas, rather than in the *vis medicatrix.* This he called sentimental Philanthropy. The conflict between the sentimental and scientific methods in social science has come from the intrusion of what may be called the sympathetic Bias—that is, the former class allow their emotions to predominate over their judgments, while the latter subordinate their feelings of sympathy to their faculty of reason. The sentimentalist employs in sociology the empiric method; in ethics he builds upon intuition; in political economy he favors the principle of co-operation. The innumerable Reforms, Leagues, and Associations are evidences of the unscientific nature of the remedy administered for deep-seated evils. Therefore, all measures of public relief must depend for their success on the correctness and certainty with which the laws of mental and biological science are applied; and the legist must likewise depend, not on short-lived and hastily-contrived plans for relief, but on the logical precision with which he draws his conclusions from these scientific studies to shape the course of his present and future policy. M. Fouillée declares that the aim of philanthropy will be to establish among the social classes *solidarité*—union between the rich and the poor. In the terms of evolution, our modern Philanthropy will produce a state of social *equilibrium*—"a state of human nature and social organization such that the individual has no desires but those which may be satisfied without exceeding his proper sphere of action, while society maintains no restraints but those which the individual voluntarily respects." * Unhappiness will be the result of imperfect adjustment of faculties to their functions and conditions, while happiness will consist in the due exercise of all the faculties consistent with the similar exercise of the like faculties of others. Without one word of displeasure to those tender-hearted philanthropists who have committed grievous errors by short-sighted plans, let us speak with pleasure of the labors of Arkwright, Stephenson, Whitney, Bessemer, Siemens, and others—scientific philanthropists, who have been all the time "weaving the web of concord among nations." The spirit that animated Faust to dig and drain vast territories has led these practical

* "First Principles," p. 512.

men to cautiously work out the application of the inventions and discoveries in science to art and industry. The difference between the Humanitarian, who is looking at things as they should be, and the sociologist, who deals with things as they are, represents accurately the distance between the Ideal and the Real. The true philanthropist will take that golden mean,—a man who, while maintaining the just equipoise between the emotional, non-discursive side, and his intellectual and analytic nature, will give wide range to his finer sympathies, "so uniting philanthropic energy with philosophic calm."

THE WORLD'S GEYSER-REGIONS.

By A. C. PEALE, M.D.

THERMAL springs, or those whose mean annual temperature exceeds that of the locality in which they are found, are almost universal in their distribution. This definition, of course, includes more than the springs usually called warm or hot, for, if the temperature exceeds, no matter in how small a degree, the mean temperature of the place in which it rises, it is truly a thermal spring. There will, of course, be a variation according to geographical position. Thus a spring which has a temperature of only a few degrees above the freezing-point would be a thermal spring in Siberia, where the ground is frozen constantly to the depth of six hundred and thirty feet, thawing out only a few feet in summer, and where the mean annual temperature is about 12½° Fahr.; whereas, in the West Indies, or in the Eastern Archipelago, it would be a cold spring. Warm and hot springs are also widely distributed. With the exception of Australia, no continent is without them, and even here they may be said to exist in a fossil state, for sinters and siliceous deposits are found in New South Wales, in a basaltic and trachytic region, indicating the former presence of hot springs, and possibly of geysers. Of course, hot springs are less widely spread than those which are simply warm, being found mainly in districts which have been affected by volcanic action, or where the rocks, from which they flow, have been subjected to disturbances such as occur in mountain elevations. Latitude, however, has no effect, for we find them equally hot in the Arctic regions and under the equator.

They are found in the frozen fields of Siberia and on the islands of Alaska, while the Andes have boiling springs from one end to the other. Venezuela and Patagonia, at the extremes of South America, both have their hot springs. When we come to geysers, we find them still more limited in their occurrence, and yet even they are confined to no particular quarter of the globe, for each continent appears to have its geyser-region. North America has the geysers of the Yellowstone National Park; Asia, a geyser-region in Thibet; while the Iceland geysers may be considered as belonging to Europe, and the New Zealand field to Australasia. Africa and South America seem to be

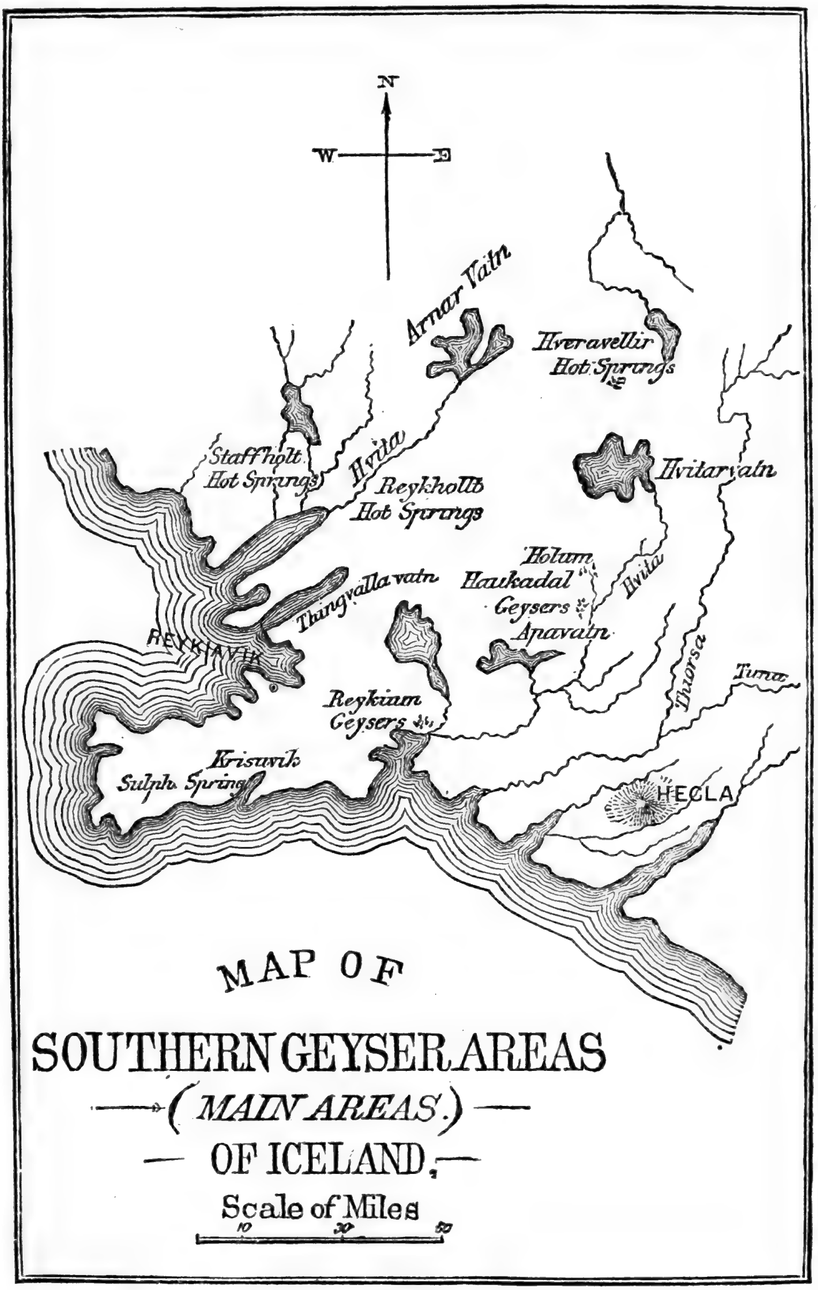


Fig. 1.

left out, and yet the comparatively unimportant geyser area of the Azores can perhaps be considered the African representative, while in the boiling lake of Dominica, and the water-volcano of Guatemala, Central and South America may be said to have geysers on a grand scale.

The difference between geysers and ordinary hot springs is not readily explained, nor always recognized, although the difference between a quiet hot spring and a geyser in active eruption is very marked. However, these are the extremes, and between the two there is every grade of action. Some geysers at times appear as quiet springs, and others are constantly in active ebullition. A geyser may be defined to be a periodically eruptive or intermittent *hot* spring, from which the water is projected into the air in a fountain-like column. The word *hot* in this definition is italicized because springs containing a large amount of gas may simulate geysers, as in the case of the Kane geyser-well in Pennsylvania, which spouts regularly, and the artesian well at Rank Herkany, in Hungary, which is fourteen hundred and fifty-seven feet deep, and spouts at regular intervals to the height of one hundred feet. Nordenskiöld discovered an intermittent cold geyser-like spring spouting through the ice-field of Greenland about thirty miles from the coast. Almost all the constantly boiling springs have periods of increased activity, and those which spout only a few feet into the air have been classed as *pseudo* geysers. There are several localities of the latter in the United States, particularly in California, and Nevada. The geysers of California belong to this class, as do also the mud-volcanoes of Southern California, although some of the latter throw columns of water to the height of twenty feet, and are true geysers. Besides the Yellowstone National Park, the Haukadal area in Iceland, and the Taupo region of New Zealand, which are the geyser-regions *par excellence* of the world, there are a number of places where a few individual geysers are known, besides the Thibet area and that of the Azores. In Mexico, at Aguas Calientes, near San Luis Potosi, there is a geyser which spouts to the height of ten or twelve feet. The Volcan de Agua, or water-volcano, of Guatemala, and the boiling lake of Dominica have already been referred to. The latter has been known since 1777. It is a seething caldron of unknown depth, measuring two hundred by more than one hundred yards, situated in the Grand Soufrière of Dominica, at an elevation of twenty-four hundred feet above sea-level. It is sometimes quiet, with a temperature of 96° Fahr., and at others is in active ebullition, with a temperature above the boiling-point, the water being thrown in jets into the air with a noise like the discharge of artillery. At Atami, in Japan, there are intermittent springs which spout about six times daily, although not with any exact regularity. An immense volume of steam and slightly sulphureted water is ejected. Geysers are found in Batachian, one of the Moluccas, and at Nolok on Celebes there is a bowl-shaped spring seventy-five feet in diameter by twenty feet in depth that has eruptions reaching the height of fifty feet. There are other localities on the same island, and in Java also are several localities, some of which have mud-geysers that spout twenty or thirty feet. The springs of Savu-Savu on Vanua Levu, in the Feejee Islands, are *pseudo* geysers.

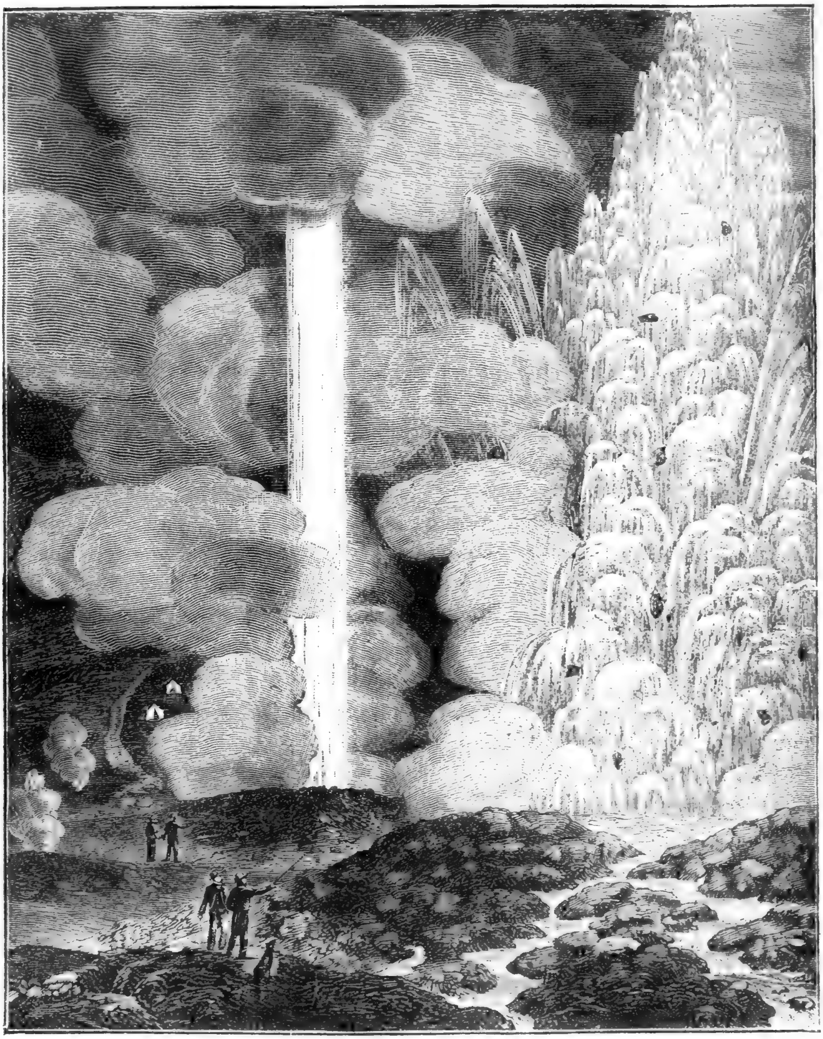
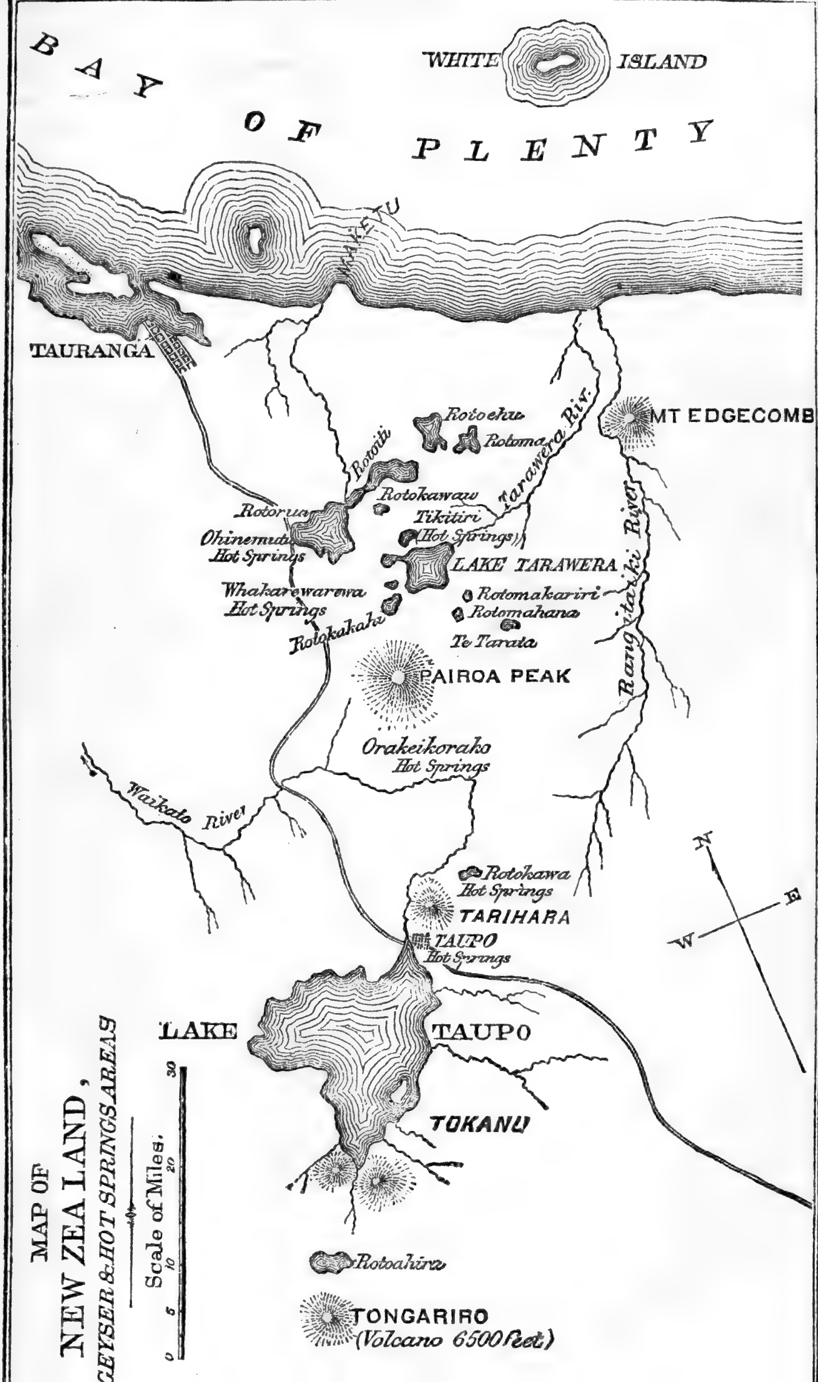


FIG. 2.—THE ERUPTION OF THE GEYSERS IN ICELAND, AS SEEN BY HENDERSON IN JULY, 1814.

The latter were owned by an old woman who was captured by a chief in 1863, and cooked in her own springs. Miss C. F. Gordon Cumming, referring to this, says: "She was past seventy, and must have been very tough and smoke-dried, but as in her younger days she had been a regular Joan of Arc, leading her tribe to battle, and herself fighting hand to hand with a hatchet, he determined to eat her. So he had her cooked with the sixteen men, and made a great feast, and then to spite the people, before leaving the district, he attempted to choke up all of the springs, in which amiable effort he partially succeeded. These springs were also a favorite place for depositing all superfluous babes, especially girls, who never got much of a welcome. They were popped in alive, like so many lobsters, and treated with quite as little ceremony." Next to the Iceland geysers, which we rank below those of New Zealand and the Yellowstone Park, the most important are probably those of Thibet, although our knowledge of them is very meager. They are in Great Thibet, in the province of Chamnamring, called Chang, near Lake Namcho, or Tengri Nur, and were discovered by T. G. Montgomerie, who described them in the "Journal of the Geographical Society of London." There are six localities in the region, of which the most important are Chutang Chaka, Peting Chuja, and Naisum Chuja. At the latter, the highest temperature recorded was 183° Fahr., and the boiling-point of water was $183\frac{3}{4}$° Fahr. The first locality had fifteen hot springs, whose waters had a temperature of 166° Fahr., the boiling-point here being 186° Fahr. Peting Chuja is the principal geyser area, and a dozen columns of hot water are described as issuing from a large stony plateau and rising to a height of forty or fifty feet, producing so much steam that the sky was darkened, and so much noise that the travelers could not hear one another speaking. Similar jets were also noticed, rising to about the same height from the middle of the adjacent river, Lakû chu. The stony plateau or platform spoken of is undoubtedly a platform or mound of siliceous sinter, so common to geyser areas.

The Azores mark one of the volcanic centers of the Atlantic Ocean ridge, on which also Iceland lies. The Island of San Miguel, or St. Michael's, has hot springs in all parts, but especially in two places at the West End, in the valley of Furnas. This valley is almost circular, about twelve miles in circumference, and surrounded by volcanic mountains. Through it flows the Ribeira Quinta, or Warm River. The springs are of high temperature, and include some that spout to a height of twelve feet. They are at one end of the valley, surrounded by deposits of siliceous sinter, which forms rims eight to ten inches in height around the individual springs. The "Great Caldeira," or Boiling Fountain, is the principal geyser.

The very name, *geyser*, testifies to Iceland's historical precedence as the land of geysers. The earliest writings in relation to the island are silent in regard to them, the first mention made being by Saxo Grammaticus, who wrote in the twelfth century. Are Frode does not refer to them in the "Icelandic Annals," A. D. 1070–'75, although he lived near their present locality. If they broke forth subsequent to that period, it is surprising that not the least notice should be taken of their appearance. It must be remembered, however, that, in all but


BAY OF PLENTY
WHITE ISLAND
MAKETU
TAURANGA
MT EDGECOMB
Rotoehu
Rotoma
Rotoiti
Tarawera Riv.
Rotokawaw
Rotorua
Tikitiri
(Hot Springs)
Ohinemutu
Hot Springs
LAKE TARAWERA
Whakarewarewa
Hot Springs
Rotomakariri
Rotomahana
Rotokakahi
Te Tarata
Rangitaiki River
PAIROA PEAK
Orakeikorako
Hot Springs
Waikato River
Rotokawa
Hot Springs
TARIHARA
TAUPO
Hot Springs
N
E
W
LAKE
TAUPO
TOKANU
Rotoahira
TONGARIRO
(Volcano 6500 feet)
MAP OF
NEW ZEALAND,
GEYSER & HOT SPRINGS AREAS
Scale of Miles.
0
5
10
20
30

highly civilized nations, physical events that do not have an immediate effect upon their worldly interests are received with indifference or apathy. Pliny, we know, gives a circumstantial account of the eruption of Vesuvius, A. D. 79, but does not mention the destruction of Herculaneum and Pompeii. It is probable that the Iceland geysers originated in prehistoric times. *Geyser*, *geysar*, *geiser*, or *geisir*, as it is variously spelled, is an old Icelandic word, meaning *gusher*, or *rager*, and is derived from the verb *geysa*, or *gjosa*, to gush, to rage, or to burst forth, to be impelled. In Iceland, in native usage, it is a proper name, being applied not only to the Great Geyser, but also to another fountain at Reykium. The word, however, has become an appellative or common name for the whole class of boiling fountains that spout hot water intermittently, just as the term *volcano* is derived from the name of one of the vents in the Lipari Islands.

The geysers of New Zealand are found on the North Island, scattered through the area which extends from Tongariro (a semi-active volcanic cone), in about the center of the island, to the Bay of Plenty. They have long been known to the natives, who have no traditions as to their age, but from time immemorial have used the quiet hot springs to warm their huts and to cook their food. Every hut has its boiler close to the door; bread is baked on large slabs of stone, placed over the hottest portions of the ground; and on others, not quite so hot, the lazy recline, wrapped in blankets, enjoying Vulcan's heat. In these respects the Maoris have the advantage over our North American Indians, who have always avoided the Yellowstone region on account of their superstitious fears.

The first white man who ever visited what is now the Yellowstone Park was undoubtedly John Colter, who was a member of Lewis and Clarke's celebrated expedition, and returned to the Upper Missouri country in 1807, and passed around Yellowstone Lake, or, as it was then called, Lake Eustis. His tales of the region were so wonderful that it was derisively called "Colter's Hell." As far back as 1844, James Bridger and Robert Meldrum, two noted Western trappers and guides, were said to have described some of the springs and geysers of the region, but their stories were so marvelous that they were not believed. The first printed description ever published was probably that given in a Mormon paper, called "The Wasp," published at Nauvoo, Illinois, in 1847. The unknown writer of this article undoubtedly visited the Lower Geyser Basin of Firehole River. Authentic information of the region was also derived from a prospecting party who visited the Lower Geyser Basin in 1863, under the leadership of Captain W. W. De Lacey. In 1869 Messrs. Cook and David E. Folsom, with another prospecting party, visited what is now the park, and the latter wrote an account of its wonders which was published in the "Western, or Lakeside Monthly," for July, 1870, where it was wrongly credited to Mr. Cook. The Washburn expedition of 1870 followed, the results of which were published in "Scribner's" and in the "Overland Monthly," attracting universal attention. In 1871 Dr. F. V. Hayden, the 'father of the Yellowstone National Park,' made his first exploration, and published the first *scientific* account of its phenomena. Since then it has become known all over the world. Thousands of tourists have visited it, and the bibliography of the park includes a list of nearly one hundred publications in relation to it. Space here will not permit a de-

Fig. 4.—Lower Terraces of Te Tarata or White Terrace Geyser.

tailed description of the park, nor is it necessary, but a comparison of some of its features with those of New Zealand and Iceland may be of interest. Without having seen each one of the three regions, it is, of course, difficult to make a complete comparison, and certainly it is impossible to be dogmatic. Still, Nature works according to laws that are the same in all parts of the globe, and a view of any one of the localities will, to a great extent, help to explain phenomena observed in either or both of the others. The comparison can be the more readily made when the American locality is the one actually observed, as the others have long been known, and quite thoroughly studied and described. The maps of the three great geyser-regions present the best comparative view of them. Expressed in figures, the areas within which the springs are included are as follow :

	Square miles.
Iceland	5,000
New Zealand	2,500
Yellowstone National Park	3,578

In the southern Iceland region, which includes the Haukadal locality, there are about six areas or groups of hot springs, which are from forty to fifty miles apart. In New Zealand there are some ten groups, the greatest distance between them being about fifteen miles. In the Yellowstone National Park, there are from thirty to forty localities or groups, some quite close together, and others sixteen miles apart. In Iceland only three of the areas have geysers of note. In the Yellowstone Park eight, at least, have good spouters, and New Zealand has fully as many localities. The following table compares some of these groups. It should be premised, however, that the individual groups included under the Yellowstone Park are not a portion of the thirty or forty localities just enumerated, but subdivisions of some of them. The Upper Geyser Basin and the Lower Geyser Basin of Firehole River are really comparable with the Haukadal area, and yet the first two comprise respectively 2,560 acres and 19,200 acres.

GROUP.	Locality.	Area in acres.	Number of springs and geysers.
Geyser area of Haukadal	Iceland	20	100
Geyser area of Reykium	"	50	100
Siliceous plateau at Orakeikorako	New Zealand	1	76
Te Tarata, and east side of Rotomahama	" "	6¼	85
Castle Group Mound	Yellowstone National Park.	3¼	15
Giantess Group	" " "	18	55
Grand Group	" " "	30	70
Fountain Group	" " "	15	17

In the number of springs and noted geysers, the Yellowstone National Park and New Zealand far exceed Iceland, in which "The Great Geyser" and Strokhr are the only two prominent spouters. As to the number of springs in New Zealand, there are no definite data, but they appear to be numerous. In the Yellowstone Park, over two thousand springs have been enumerated and mapped, and among them are seventy-one geysers, of which twenty are known to spout to a height of not less than fifty feet. Of course, in each of the three countries, there are hot springs outside of the areas as here indicated ; and, if these are taken into account, the American localities will exceed the others, especially if the California and Nevada springs are counted.

However, leaving the latter out of account, we find that in the adjacent country both north and south of the park there are springs on the same north and south line with the geyser-basins of Firehole River; and, if they are considered as a part of the same system, the length of the line of thermal activity is about two hundred miles.

As to the heights to which the geysers throw the columns of water, there is probably but little difference between the three regions, although the Yellowstone Park has, perhaps, a greater number which erupt regularly to a height of one hundred feet or more. The records of the New Zealand geysers are, however, somewhat deficient as to data on this point. The following table presents some comparisons as to this:

NAME OF GEYSER.	Location.	Maximum height.
		Feet.
Great Geyser	Iceland	212*
Strokr	"	162
Geyser at Reykium	"	40
Waikite, at Rotorua	New Zealand	100
Te Puia-nui, near Tokanu	" "	100†
Crow's Nest, near Tanpo	" "	50
Principal geyser at Orakeikorako	" "	30
Principal geyser on White Island	" "	100
Te Tarata, at Rotomahana	" "	50
Excelsior	Yellowstone National Park.	300
Giantess	" " "	250
Bee-Hive	" " "	219
Grand	" " "	200
Castle	" " "	200
Giant	" " "	200
Old Faithful	" " "	150
Union	" " "	114
Comet	" " "	100
Great Fountain	" " "	100
Steamboat-Vent	" " "	100
Riverside	" " "	80
Fan Geyser	" " "	75
Oblique	" " "	75
Pelican Creek mud-volcano	" " "	75
Solitary	" " "	70
Grotto Geyser	" " "	60
Fountain	" " "	50
Cliff Geyser	" " "	50‡
Surprise Geyser	" " "	30‡

This list might easily be increased, but it includes all the principal geysers. The bulk of the water in the New Zealand springs is so great that in most cases the columns during eruption do not attain great heights.

* Three hundred and sixty feet is mentioned by Olafson and Povelson, but is probably an estimate.

† A height of two hundred feet has also been recorded for one of the New Zealand geysers.

‡ These are two new geysers discovered in 1883 by Mr. Arnold Hagues, division of the United States Geological Survey.

One point which attracts attention, when the maps of these three regions are compared, is, that in each the hot springs appear to be associated with lakes. In Iceland there are six, in New Zealand fifteen, and in the Yellowstone Park four. All are of considerable size—Lake Taupo, in New Zealand, is twenty-five miles long by twenty wide; Yellowstone Lake measures twenty miles in length, by an average width of about eight miles. In Iceland, Hvitarvatn is nearly ten miles by eighteen; and Thingvallavatn has a length of about twenty miles, and a greatest width of ten or twelve miles. It is interesting in this connection to note that the Thibet geysers occur near a lake. Another point of resemblance is in the character of the deposits, which are alike in appearance, structure, and chemical composition, with the exception, perhaps, of some of the minor constituents. Silica is the predominant element in them, and is derived from the prevailing rocks. In the following table are some comparisons on these points:

LOCALITY.	Grains of silica to a gallon of water.	Percentage of silica in deposits from waters.	Character of rocks.	Percentage of silica in rocks.
Iceland	21·70 to 37·80	84·43 to 98·00	Palagonite and phonolite	41·28 72·3
New Zealand	11·48 to 43·95	77·35 to 94·20	Rhyolite and trachytes	70·0
Yellowstone Park	7·84 to 53·76	73·00 to 92·64	Obsidian and quartz-trachytes	64·60 to 77·90

The waters of New Zealand contain a much larger percentage of sodium chloride (common salt) than is found in those of the Yellowstone Park, or in the springs of Iceland.

The springs and geysers of New Zealand can be grouped in three parallel lines, and a similar linear arrangement is seen in the Yellowstone Park, and appears to be analogous to the linear arrangement so frequently noted in the case of volcanoes.

The plateau upon which the Iceland geysers is situated is surrounded on three sides with glaciers. In the Yellowstone Park, glaciers are things of the past; to-day only the erratic bowlders and scratches in the Yellowstone Valley testify to their former presence. In New Zealand the atmosphere is humid, and favorable to a growth of vegetation not found in either of the other regions. In New Zealand there are springs of greater size than those of either Iceland or the Yellowstone Park. In neither of the latter is there a hot lake like Rotomahoma, which is a mile wide by a mile and a quarter in length, and has an average temperature of 78° Fahr. The largest springs at present in the park are the Grand Prismatic spring, measuring two hundred and fifty by three hundred and fifty feet, and the small hot lake in the Lower Firehole Basin, which is one thousand feet long by seven hundred and fifty feet in width. In the past, however, the whole Lower

Basin was covered by a lake, which possibly may have been a hot lake. In our American region, siliceous cones surmounting broad sloping mounds seem to predominate. Although New Zealand has a number of cones or chimneys, the large basins are more numerous. The pool of Te Tarata measures eighty by sixty feet, and the basin of Otakapuarangi is fifty feet in diameter. The springs in Iceland are comparatively small, as a rule, and chimney-like forms are not numerous.

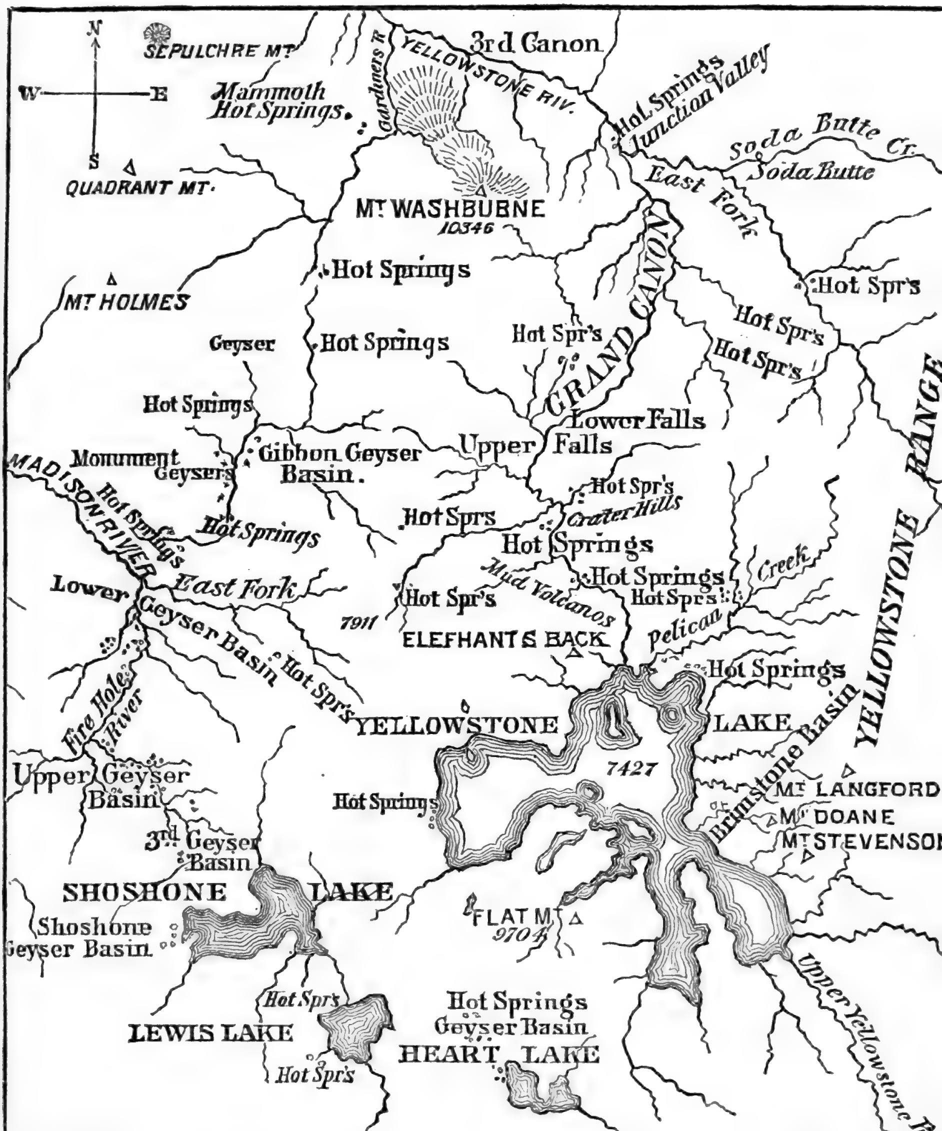


FIG. 5.—MAP OF YELLOWSTONE NATIONAL PARK, SHOWING THE DISTRIBUTION OF HOT SPRINGS AND GEYSERS. (Scale, ten miles to the inch.)

At Reikum the geysers have no deposits, and the "Great Geyser" at Haukadal is situated on the summit of a broad and rather gently sloping mound. Some of these differences will be rendered more apparent when placed in a tabular form:

NAME OF GEYSER.	Location.	Size at top.	Size at base.	Height of cone.
Great Geyser	Iceland	56 feet diameter	101 yards by 75 yards	12 feet.
Waikite	New Zealand		100 feet diameter	15 feet.
Crow's Nest	" "	6 feet diameter.	20 feet diameter	6 or 7 feet.
Pohutu	" "			20 feet.
Union	Yellowstone Park		18 feet circumference.	3 feet.
Flat Cone	" "	55 feet diameter		20 feet.
Steep Cone	" "	55 feet diameter		25 feet.
Bee-Hive	" "	3 feet × 4 feet.	20 feet circumference.	3 feet.
Giant	" "	8 feet diameter.	24 × 25 feet.	10 feet.
Old Faithful	" "	20 by 54 feet	145 × 215 feet.	11 feet.
Castle	" "	20 feet diameter	120 feet circumference.	12 feet.
White Dome	" "			25 feet.

The Flat and Steep cones have on their summits springs or basins of eight or nine feet diameter, and rims eight or nine inches in height. The cone of the Giant rises from a platform that is four feet high, and has a circumference of three hundred and forty-two yards. The Castle is on a platform that measures seventy-five by one hundred feet, and is three feet high, and the entire mass (platform and cone) is on the summit of a mound that is composed of deposits forty feet in thickness and covers three and a half acres.

It is difficult, and perhaps impossible, to say with certainty what the relative age of these three regions is; still, there are several reasons which seem to indicate that Iceland is the youngest and the Yellowstone Park the oldest, with New Zealand occupying the intermediate position. The first reason is based on a comparison of the volcanic condition of the three regions. Iceland is still in a state of volcanic activity. It has had eruptions as late as 1860 and 1875. There are twenty volcanoes on the island, and Hecla, which is only forty miles from the Haukadal geysers, has had twenty-two eruptions since 1004 or 1005, the date of the earliest record concerning it. In New Zealand the volcanoes adjacent to the geyser areas have sunk into the solfataric stage, and the natives have no traditions of any activity in them. In the Yellowstone National Park it is hard to say positively where the ancient volcanoes stand, although Mount Washburn has been thought to be a volcanic crater, and recently Mr. Arnold Hague has stated that Mount Sheridan may be a crater much modified by glacial action.

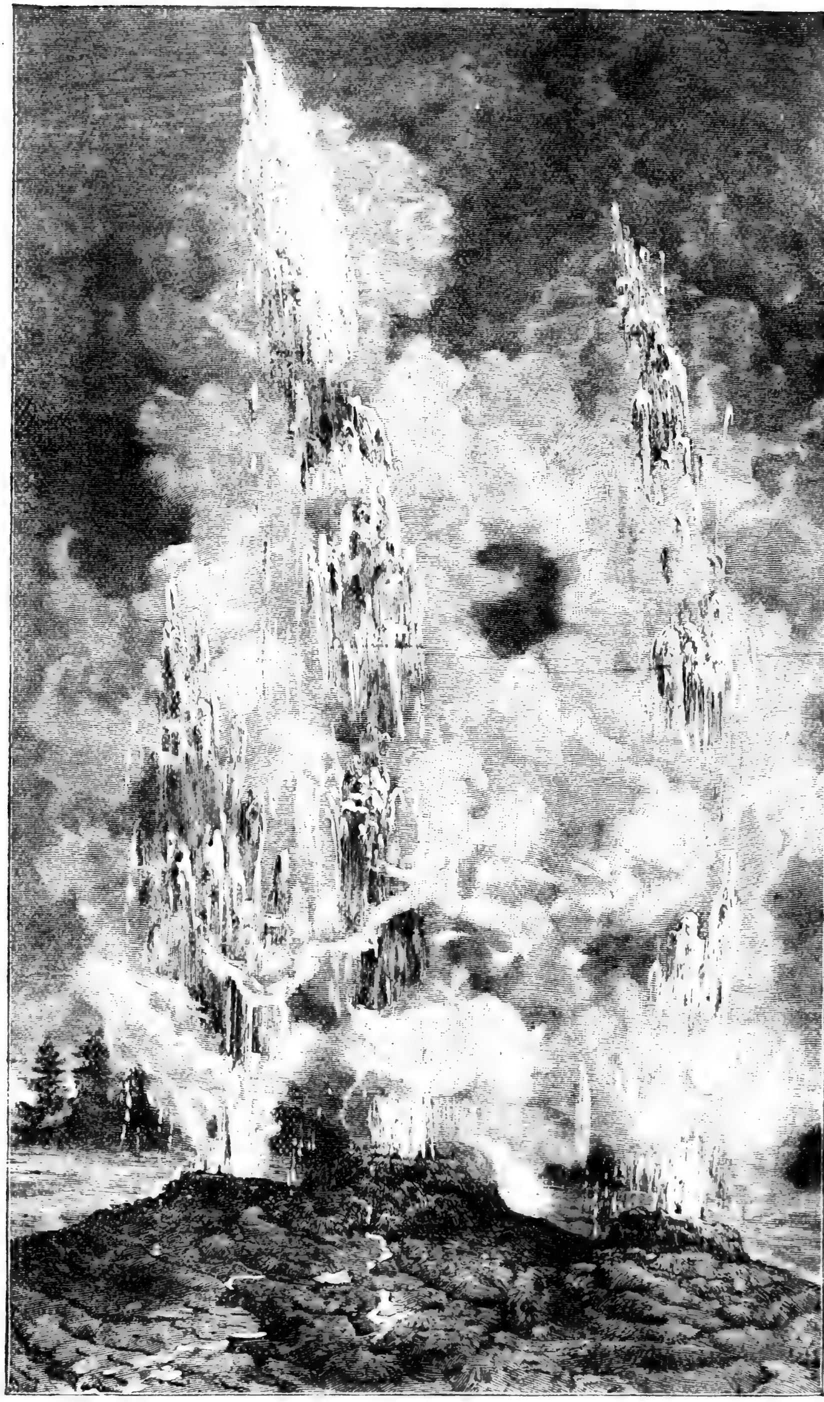


FIG. 6.—ERUPTION OF THE UNION GEYSER IN THE YELLOWSTONE NATIONAL PARK, AUGUST, 1878.

Secondly, when the deposits are compared, we find, as just stated, that the chimney-like form is most prominent in the Yellowstone region, while New Zealand, in that respect also, is intermediate between the park and Iceland. This more chimney-like form in the Yellowstone geysers has been explained by the statement that they contain more silica in solution, but, as already stated in the analysis already made, the percentage is usually smaller; the one exception is in a spring containing 53·76 grains of silica to the gallon of water, and it is a spring that has no conical mound. It has also been suggested that the dry air of our region may have some effect in this direction. We have no data at hand on this point; but the simpler and, to our mind, more reasonable cause is the greater age of our American region. Many of our geysers are secondary in their origin. Thus Old Faithful is a geyser that has broken out on the summit of a mound that had gradually closed up and become extinct. We can not compare the actual thicknesses of the sediments or depositions of the three regions, and, even if we could, the comparison would be apt to mislead us, as the rate of deposition in each region and among individual springs must be variable. A great antiquity, however, can certainly be accorded to all three of them. I will conclude these comparisons with a table of their elevations, including with them some of the other localities mentioned in this article:

	Elevation in feet above sea-level.
Savu Savu, in Feejee Islands	9
Hankadal geysers in Iceland	400
New Zealand geysers	1,000 to 1,300
Boiling Lake of Dominica, West Indies	2,400
Geysers of Yellowstone National Park	6,000 to 8,000
Geyser-region of Thibet	15,000 to 16,000

REPARATION TO INNOCENT CONVICTS.

By Dr. HEINRICH JAQUES,

OF THE AUSTRIAN CHAMBER OF DEPUTIES.

LEGISLATIVE problems are, like books, subject to vicissitudes. Solutions of the particular questions involved in single cases may seem adequate to satisfy deeply-felt wants of the public; yet it may happen that the attention of the latter is—to the scorn of the previous scientific work of years—first suddenly called to the problems by some unexpected, exciting event. It may equally well happen that a single sensational event may bring into current discussion some legislative question hitherto wholly unconsidered by science. The interest of all students is then turned for a short time to this point; its discussion occupies the saloons, fills the columns of the journals, and is echoed from the chairs of the learned; but, after a brief period of agitation, the current interest in the subject declines, other events awaken sympathy or antipathy, and the want which the solution of the question seemed destined to meet, appears to have sunk into abeyance. A third condition is also possible and not rare; it is that science and investigation—even bee-busy German science and investigation—may for years overlook the speculative problem and the real need.

The subject which now engages our attention, and the collateral one of indemnification for unjust or unjustified arrests, have not been spared fatalities of this kind. Under the passionate excitement aroused by the judicial murder of Jean Calas, in France, to which Voltaire gave a world-wide notoriety, public attention was turned with feverish anxiety to the question of indemnifying persons who had suffered under judicial sentence for offenses of which they had been found to be innocent, although the subject had never yet been made a matter of scientific consideration. The Academy of Châlons-sur-Marne made its celebrated offer of prizes for the solution of the question. The subject had a place in the memorable portfolio of the deputies to the States-General of 1789; and Louis XVI himself and his statesmen, a Necker and a Pastoret, had it on their programmes. Excessively crude and ill-considered attempts were made to solve it. Two of the prize-writers, Brissot de Warville and Philippon de la Madeleine, proposed decorations, especial rewards, and national honors for persons who had suffered under unjust condemnation, as if the bearing of a wrong and the rendering of a service stood on the same level; as if the award of distinctions and elevation in rank could be made adequate equivalents for injuries inflicted by the mistakes of the state's agents. The visionary mood of the French people subsided, the excitement passed away; and, although the question has never since been lost sight of in the criminal literature of the country, it has not yet been solved. Napoleon III of his own initiative issued pardons in several cases in which no right of appeal had been recognized in legislation. In Italy, a mark was made by Filangieri's efforts to introduce reforms, and legislative recognition of the right to indemnity was secured for the first time in the laws of Leopold II of Tuscany, and of Naples; but the question was overlooked in the codification of the laws of the new kingdom, and the noble efforts of Carrara and Lucchini to secure consideration of it have remained to this day without practical result. In England, except for Jeremy Bentham, juridical literature is, so far as we know, silent on the subject. Those acts of Parliament which have awarded indemnities in cases of peculiar hardship, as in those of the German preacher Hessel and of Bewicke, have advisedly left out of sight the point of principle, which Lord Grey warned his countrymen was entirely sentimental and unapproachable. The cantonal legislation of Switzerland, which Geyer has recently elucidated in a number of valuable expositions, is, in respect to our question, far in advance of that of the whole continent. In Germany, Heinze brought the problem in its wider aspects under discussion about ten years ago, and the German *Juristentag* began a searching investigation of it. But so remote was the subject then for the otherwise far-sighted legal world of Germany, that the *Juristentag* had to speak three times upon it, at Hanover, Nuremberg, and Salzburg, before it could arrive at a *communis opinio.* This ten years' work would have gone without result, had not a number of striking cases of unjust condemnation recently grieved the public sense of right, led to the introduction of motions in the German Reichstag and the Austrian Reichsrath, and called out a considerable literature of pamphlets and essays by Geyer, Jaques, Schwarze, Lilienthal, List, Kronecker, Gernerth, Bar, Bähr, Jacobi, and the anonymous author of the admirable little treatise, "Gerichtsaal." If, on the other hand, we review the German literature—including discussions of principles and text-books—on criminal process up to the papers that were prepared for the *Juristentag* of 1874, we shall find it wholly silent with respect to our question. This silence is easily understood, in view of what we have said. For the monographic division and subdivision to which legal science, after premature and futile efforts to give it philosophical comprehension, was subjected, with the object of sounding it in detail and mastering the concrete material, involved the laying aside of those problems which had to be solved rather by a simultaneous and uniform review than by any special legal study. To this class of problems belongs our question, which appears to partake at once of the nature of public and private right ; to it, to cite a pair of related examples, belong the testing of the constitutionality of laws by the courts, which enters at the same time into the administrative and the judicial domain ; and the question of the distinctions between civil and criminal injuries, the scientific solution of which is deduced from both private and criminal law. To it belongs also the question of the responsibility of the state for the faults of its officers, the solution of which again presumes a weighing of factors of private and public law, and this solution science has not until very recently troubled itself to advance.

These changes of aspect and alternatives, by reason of which the cause of reproach exists, that, except in Switzerland, the right of innocent convicts to indemnification has not till the present time received legislative recognition in any European state, have their deeper causes in closest connection with the course of civilizational and political development. So long as the right of the whole public was embodied in the absolute lord's will—so long as the principle prevailed of that *lex regia* transmitted from the Roman law which said, "*Princeps legibus solutus est*"—so long could there not be the remotest suggestion of the right to an indemnity based upon the fact of an unjust condemnation, or of an appeal by the individual against the state. How could a claim be established against the state, which could not offend, or against its agents, who as such could do no wrong? Even in a much later stage of development, at the epoch when the germs of the modern legal state began to strike root in the public consciousness—at the epoch when there no longer existed any hesitation in affirming that the state could justly carry out its action toward individuals only according to constitutional and legal forms, and that, on the other hand, the individual must be given valid security and effective protection in his constitutional rights and liberties—even at this epoch the ground was not prepared for the admission of claims for damages in cases of injurious misjudgments by the officers of justice. It could indeed be remarked on this point that the state organs could injure and wrong the individual if they designedly or carelessly failed to regard constitutional rules as toward him. But if there could be in this case consideration of claims for damages, did they not have to rest upon two principles that stood in inseparable connection with the traditional categories of the Roman civil law, which has prevailed even in public life until very recently? First, upon the fact that a wrong, of design or negligence, is in question; and, second, upon the other fact that the injured person has to look for the bearer of the responsibility in the matter, not to the state, a juristic impersonation incapable of wrong, but to the individual author of the injury himself, in the present case to the judge, who has not fully discharged his official duty in the particular case, but has rather violated it. Then arose the further advanced idea, only corresponding with the gradual growth of strength in the civic feeling and with the more deep-reaching demands of freedom, that the state itself ought to make amends for injuries to civil rights by its officers, and that this duty of indemnification was imposed upon it, when, although still only objectively infringing upon the sphere of individual rights, it should be found doing wrong and inflicting injury, and that independently of and wholly uninfluenced by the consideration of whether or not a subjective injury existed in consequence of its act.

Yet another most important advance had to be made to give full clearness to the position in public law of the individual as toward the state, and sharply to describe the circle of competence of the public as well as of individuals toward one another. It was to secure an acknowledgment resting upon economical and social as well as upon ethical principles, that all the burdens that are laid upon individuals must be laid with perfect impartiality; and that if the state would be a law-regulated state, a kingdom of justice in the true sense of the word, it should not oblige any individual to make a greater sacrifice for it than all the others.

Not till this principle was recognized was a solid basis gained for the legal right of an innocent convict to demand an indemnity from the state. It must now be plain to every one, and as clear as the sunlight, that the same rule should prevail with respect to the burden of justice which the state imposes upon individuals as with respect to the burden of taxation or of military service. As the state exacts a universal military obligation which no individual has a right to evade, so, inversely, the individual who enjoys the knowledge of his own innocence has the right to require that the law, to which every one without exception has to submit unconditionally without resistance and without objection, shall commit no offense toward him. If, however, by a casual concatenation of circumstances, or through erroneous suspicions, or by means of false evidence, more suffering or a greater sacrifice is imposed upon one individual than all the others have to bear, it becomes the unavoidable obligation of the state to make amends to him for the excessive burden he has to carry. The duty is an obligation in the strongest sense of the word, and not in the remotest degree a mere matter of equity or of humanity or of favor. For why does this individual have, at the price of his freedom, his honor, his social position, his power to make money, his health and ability to work, of pain and care, and perhaps of misery to his family, to appear and make a sacrifice of himself that the judicial department of the state may exercise its function? Why must he suffer for the mistakes, even if they are unavoidable mistakes, of the state organs? If any one is assessed too highly by some mistake in taxation, even though the error may be in fact pardonable and perhaps unavoidable, does not the financial department consider itself obliged to return to him the whole amount of the excess of the levy, with interest? And if another person has been obliged without any real ground of justice to make a gratuitous sacrifice of his best goods to the judicial administration of the state, is not the state unavoidably pledged to make to him as adequate a reparation for the wrong as is possible? All the analogies of private law, which have been adduced in rebuttal of the state's obligation, fail in the application. The maxim "*qui suo jure utiter, neminem lædit*" ("he who exercises his own right is responsible for no one's injury") does not apply, for the prosecuting state can exercise *suum jure* (its right) only against one who has been delinquent, but no right, rather a wrong, toward a guiltless person. Inapplicable also is the maxim, "*casus nocet domino*" ("damage from accident falls upon the lord"), for if by a false generalization the error of judicial organs is designated as a *casus* (an accident), as *force majeure* (superior force), the *dominus* (or lord), upon whom the burden of the *casus* (or accident) follows, is no other than the state itself. Futile and confusing to clear judgment is also the introduction of other apparently closer-lying analogies of private law, as, for example, of the right of condemnation for railroad and mining enterprises, insurance against violence, and the like. For the legal claim we are speaking of here rests on a basis of public right, on the just limitation of the right and duty of the state as the incorporation of the whole public as toward the individual, and *vice versa;* it has, besides, its own independent bases, and the other cases are essentially not competent to sustain it.

Respecting the provisions of a law embodying the principle we have been trying to elucidate, but little more can be said than to refer to the bill which has been approved by the Austrian Chamber of Deputies, and whose passage in the Upper Legislative House is anticipated. The easiest accessibility to the courts for the parties, an obligatory stipulation for the gratuitous representation of poor suitors in establishing their claim, an official preliminary investigation, public oral pleadings according to the rules of civil process, the free examination of witnesses, the designation of the amount of indemnity after an open judicial estimation, inquiry into every kind of injury that may have been suffered, and a system of procedure corresponding with these conditions, are obvious points. To these may be added the lapse of the privilege of making the claim after a properly defined interval (one year in the Austrian bill), and in cases where the condemned person has voluntarily filled out his sentence. Extreme care should, however, be taken to give a precise definition to the latter limitation; for it would be wholly unjustifiable to punish the thoughtlessness or ordinary negligence of an uneducated or imperfectly informed person, in failing to produce the evidence in his favor, with the loss of the right of appeal. But gross negligence may be considered in concrete cases to have been designed.

We have thought it proper to limit our discussion in this place to the question of the indemnification of persons who have been unjustly condemned, and have advisedly left out of view the question, closely connected with it in principle, of damages to those who have been subjected to causeless prosecutions. It is well to be satisfied for the time with securing the more important object as a beginning, without imperiling it by complicating it with other conditions. The principle of the matter is carried with the first part, while the second part of our problem may be left to mature itself and pass its course of scientific discussion. In the mean time we, who have labored for ten years in this cause, will regard the result we expect soon to obtain as only a step—as an installment—and will be encouraged by our success to strive for the attainment of the other object.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXXII.

SINCE the publication of my last paper, I have been told, by a lady to whom the readers of "Knowledge" are much indebted, that in the fatherland of potatoes, as well as in their adopted country, they are always boiled or steamed in their jackets; that American cooks, like those of Ireland, would consider it an outrage to cut off the protecting skin of the potato before cooking it; that they are more commonly mashed there than here, and that the mashing is done by rapidly removing the skins, throwing the stripped potato into a supplementary saucepan or other vessel, in which they may be kept hot until the preparation is completed.

Returning to the subject at the point where I left, it I must endeavor to describe the effect of cooking on gluten. It is usually described as "partly soluble in hot water." My own examination of this substance suggests that "partially soluble" is a better description than "partly soluble" (Miller) or "very slightly soluble" (Lehmann). This difference is not merely a verbal quibble, but very real and practical in reference to the *rationale* of its cookery. A partly soluble substance is one which is composed of soluble and also of insoluble constituents, which, as already stated, is strictly the case with gluten in reference to the solvent action of hot alcohol. A very slightly soluble substance is one that dissolves completely but demands a very large quantity of the solvent. I find that the action of hot water on gluten, as applied in cookery, is to effect what may be described as a partial solution, that is, effecting a loosening of the bonds of solidity, but not going so far as to render it completely fluid.

It appears to be a sort of hydration similar to that which is effected by hot water on starch, but less decided.

To illustrate this, wash some flour in cold water so as to separate the gluten in the manner described in No. 29; then boil some flour as in making ordinary bill-sticker's paste, and wash this in cold water. The gluten will come out with difficulty, and when separated will be softer and less tenacious than the cold-washed specimen. This difference remains until some of the water it contains is driven out, for which reason I regard it as hydrated, though I am not prepared to say that the hydration is of a truly chemical character, not a definite compound of gluten and water, but rather a mechanical combination—a loosening of solidity by a molecular intermingling of water.

The importance of this in the cookery of grain-food is very great, as anybody who aspires to the honor of becoming a martyr to science may prove by simply making a meal on raw wheat, masticating the grains until reduced to small pills of gluten, and then swallowing these. Mild indigestion or acute spasms will follow, according to the quantity taken and the digestive energies of the experimenter. Raw flour will act similarly but less decidedly.

Bread-making is the most important, as well as a typical example, of the cookery of grain-food. The grinding of the grain is the first process of such cookery; it vastly increases the area exposed to the subsequent actions.

The next stage is that of surrounding each grain of the flour with a thin film of water. This is done in making the dough by careful admixture of a modicum of water and kneading in order to squeeze the water well between all the particles. The effect of insufficient enveloping in water is sometimes seen in a loaf containing a white powdery kernel of unmixed flour.

If nothing more than this were done, and such simple dough were baked, the starch-granules would be duly broken up and hydrated, the gluten also hydrated, but, at the same time, the particles of flour would be so cemented together as to form a mass so hard and tough when baked that no ordinary human teeth could crush it. Among all our modern triumphs of applied science none can be named that is more refined and elegant than the old device by which this difficulty is overcome in the every-day business of making bread. Who invented it, and when, I do not know, but perhaps Mr. Clodd can tell us. Its discovery was certainly very far anterior to any knowledge of the chemical principles involved in its application.

The problem has a very difficult aspect. Here are millions of particles, each of which has to be moistened on its surface, but each when thus moistened becomes remarkably adhesive, and therefore sticks fast to all its surrounding neighbors. We require, without suppressing this adhesiveness, to interpose a barrier that shall sunder these millions of particles from each other so delicately as neither to separate them completely, nor allow them to completely adhere.

It is evident that if the operation that supplies each particle with its film of moisture can simultaneously supply it with a partial atmosphere of gaseous matter, the difficult and delicate problem will be effectively solved. It is thus solved in making bread.

As already explained, the seed which is broken up into flour contains diastase as well as starch, and this diastase, when aided by moisture and moderate warmth, converts the starch into dextrine and sugar. This action commences when the dough is made, and this alone would only increase the adhesiveness of the mass, if it went no further; but the sugar thus produced may, by the aid of a suitable ferment, be converted into alcohol. As the composition of alcohol corresponds to that of sugar, minus carbonic acid, the evolution of carbonic-acid gas is an essential part of this conversion.

With these facts before us, their practical application in bread-making is easily understood. To the water with which the flour is to be moistened some yeast is added, and the yeast-cells, which are very much smaller than the grains of flour, are diffused throughout the water. The flour is moistened with this liquid, which only demands a temperature of about 70° Fahr. to act with considerable energy on every granule of flour that it touches. Instead, then, of the passive, lumpy, tenacious dough produced by moistening the flour with mere water, a lively "sponge," as the baker calls it, is produced, which "rises" or grows in bulk by the evolution and interposition of millions of invisibly small bubbles of gas. This sponge is mixed with more flour and water, and kneaded and kneaded again to effect a complete and equal diffusion of the gas-bubbles, and finally the porous mass of dough is placed in an oven previously raised to a temperature of about 450°.

The baker's old-fashioned method of testing the temperature of his oven is instructive. He throws flour on the floor. If it blackens without taking fire, the heat is considered sufficient. It might be supposed that this is too high a temperature, as the object is to cook the flour, not to burn it. But we must remember that the flour which has been prepared for baking is mixed with water, and the evaporation of this water will materially lower the temperature of the dough itself. Besides this, we must bear in mind that another object is to be attained. A hard shell or crust has to be formed, which will so incase and support the lump of dough as to prevent it from subsiding when the further evolution of carbonic-acid gas shall cease, which will be the case some time before the cooking of the mass is completed. It will happen when the temperature reaches the point at which the yeast-cells can no longer germinate, which temperature is considerably below the boiling-point of water.

In spite of this high outside temperature, that of the inner part of the loaf is kept down a little above 212° by the evaporation of the water contained in the bread; the escape of this vapor and the expansion of the carbonic-acid bubbles by heat increasing the porosity of the loaf.

The outside being heated considerably above the temperature of the inner part, this variation produces the differences between the crust and the crumb. The action of the high temperature in directly converting some of the starch into dextrin will be understood from what I have already stated, and also the partial conversion of this dextrin into caramel, which was described in Nos. 13 and 14 of this series. Thus we have in the crust an excess of dextrin as compared with the crumb, and the addition of a variable quantity of caramel. In lightly baked bread, with a crust of uniform pale-yellowish color, the conversion of the dextrin into caramel has barely commenced, and the gummy character of the dextrin coating is well displayed. Some such bread, especially the long staves of life common in France, appear as though they had been varnished, and their crust is partially soluble in water.

This explains the apparent paradox that hard crust, or dry toast, is more easily digested than the soft crumb of bread ; the cookery of the crumb not having been carried beyond the mere hydration of the gluten and the starch, and such degree of dextrin formation as was due to the action of the diastase of the grain during the preliminary period of "rising."

Everybody has, of course, heard of "aërated bread," and most have tasted it. Several methods have been devised, some patented, for effecting an evolution of gas in the dough without having recourse to the fermentation above described. One of these is that of adding a little hydrochloric acid to the water used in moistening the flour, and mixing bicarbonate of soda in powder with the flour (to every four pounds of flour one half ounce bicarbonate, and four and a half fluid drachms of hydrochloric acid of 1·16 specific gravity). These combine and form sodium chloride, common salt, with evolution of carbonic acid. The salt thus formed takes the place of that usually added in ordinary bread-making, and the carbonic-acid gas evolved acts like that given off in fermentation ; but the rapidity of the action of the acid and carbonate presents a difficulty. The bread must be quickly made, as the action is soon completed. It does not go on steadily increasing and stopping just at the right moment, as in the case of fermentation.

I remember the first introduction of this about half a century ago, and the anticipations which accompanied it. London was agitated by the bread-reform movement, and bakers were alarmed. A large establishment was opened in Oxford Street, and much amusement created by an opposition placard display in some of the neighboring bakers' shops, "Bread sold here with the gin in it." This, of course, was fallacious, as the alcohol produced by the panary fermentation is driven off by the heat of the oven. Other methods similar in principle have been adopted, such as adding ammonia carbonate with the soda carbonate. The ammonia salt is volatile itself, besides evolving carbonic acid by its union with the acid.

In spite of the great amount of ingenuity expended upon the manufacture of such unfermented bread and the efforts to bring it into use, but little progress has been made. The general verdict appears to be that the unfermented bread is not so "sweet," that it lacks some element of flavor, is "chippy" or tasteless as compared with good old-fashioned wheaten bread, free from alum or other adulteration. My theory of this difference is that it is due to the absence of those changes which take place while the sponge or dough is rising, when, if I am right, the diastase of the grain is operating, as in germination, to produce a certain quantity of dextrin and sugar, and possibly acting also on the gluten. Deficiency of dextrin is, I think, the chief cause of the chippy character of aërated bread. It must be remembered that this stage is protracted over several hours, during which the temperature most favorable to germination is steadily maintained. Other and very interesting phenomena connected with bread-making will be treated in my next.

XXXIII.

The practical importance of the fermentation described in my last is strikingly shown by the fact that, in the course of sponge-rising, dough-rising, and baking, a loaf becomes about four times as large as the original mixture of flour, water, etc., of which it was made; or, otherwise stated, an ordinary loaf is made up of one part of solid bread to more than three parts of air-bubbles or pores. French rolls, and some other kinds of fancy bread, are still more gaseous.

So far I have only named the flour, water, salt, and yeast. These, with a little sugar or milk added according to taste and custom, are the ingredients of home-made bread, but "baker's bread" is commonly, though not necessarily, somewhat more complex. There is the material technically known as "fruit," and another which bears the equivocal name of "stuff," or "rocky." The fruit are potatoes. The quantity of these prescribed in Knight's "Guide to Trade" is one peck to the sack of flour. This proportion is so small (about three per cent by weight) that, if not exceeded, it can not be regarded as a fraudulent adulteration, for the additional cost involved in the boiling, skinning, and general preparing of the small addition exceeds the saving in the price of raw material. The fruit, therefore, is not added merely because it is cheaper than flour, as many people suppose.

The instructions concerning its use given in the work above named clearly indicate that the potato-flour is used to assist fermentation. These instructions prescibe that the peck of potatoes shall be boiled in their skins, mashed in the "seasoning-tub," then mixed with two or three quarts of water, the same quantity of patent yeast, and three or four pounds of flour. The mixture is left to stand for six or twelve hours, when it will have become what is called a *ferment*. After straining through a sieve, to separate the skins of the fruit, it is mixed with the sack of flour, water, etc.

It is evident from this that it would not pay to add such a quantity in such a manner as a mere adulterant. The baker uses it for improving the bread, from his point of view.

The *stuff* or *rocky* consists, according to Tomlinson, of one part of alum to three parts of common salt. The same authority tells us that the bakers buy this at 2*d*. per packet, containing one pound in each, and that they believe it to be ground alum. They buy it thus for immediate use, being subject to a heavy fine if they keep alum on the premises. The quantity of the mixture ordinarily used is eight ounces to each sack of flour weighing two hundred and eighty pounds, so that the proportion of alum is but two ounces to two hundred and eighty pounds. As one sack of flour is (with water) made into eighty loaves weighing four pounds each, the quantity of alum in one pound of bread amounts to $\frac{1}{160}$ of an ounce.

The *rationale* of the action of this small quantity of alum is still a chemical puzzle. That it has an appreciable effect in improving the *appearance* of the bread is unquestionable, and it may actually improve the quality of bread made from inferior flour.

One of the baker's technical tests of quality is the manner in which the loaves of a batch separate from each other. That they should break evenly and present a somewhat silky rather than a lumpy fracture, is a matter of trade estimation. When the fracture is rough and lumpy, one loaf pulling away some of the just belongings of its neighbor, the feelings of the orthodox baker are much wounded. The alum is said to prevent this impropriety, while an excess of salt aggravates it.

It appears to be a fact that this small quantity of alum whitens the bread. In this, as in so many other cases of adulteration, there are two guilty parties—the buyer who demands impossible or unnatural appearances, and the manufacturer or vender who supplies the foolish demand. The judging of bread by its whiteness is a mistake which has led to much mischief, against which the recent agitation for "whole meal" is, I think, an extreme reaction.

If the husk, which is demanded by the whole-meal agitators, were as digestible as the inner flour, they would unquestionably be right, but it is easy to show that it is not, and that in some cases the passage of the undigested particles may produce mischievous irritation in the intestinal canal. My own opinion on this subject (it still remains in the region of opinion rather than of science) is that a middle course is the right one, viz., that bread should be made of moderately dressed or "seconds" flour rather than overdressed "firsts," or undressed "thirds," i. e., unsifted whole-meal flour.

Such seconds flour does not fairly produce white bread, and consumers are unwise in demanding whiteness. In my household we make our own bread, but occasionally, when the demand exceeds ordinary supply, a loaf or two is bought from the baker. I find that, with corresponding or identical flour, the baker's bread is whiter than the home-made, and correspondingly inferior. I may say, colorless in flavor, it lacks the characteristic of wheaten sweetness. There are, however, exceptions to this, as certain bakers are now doing a great business in supplying what they call "home-made" or "farm-house" bread. It is darker in color than ordinary bread, but is sold nevertheless at a higher price, and I find that it has the flavor of the bread made in my own kitchen. When their customers become more intelligent, all the bakers will doubtless cease to incur the expense of buying packets of "stuff" or "rocky," or any other bleaching abomination.

Liebig asserts that in certain cases the use of lime-water improves the quality of bread. Tomlinson says that, "in the time of bad harvests, when the wheat is damaged, the flour may be considerably improved, without any injurious result whatever, by the addition of from twenty to forty grains of carbonate of magnesia to every pound of flour." It is also stated that chalk has been used for the same purpose. These would all act in nearly the same manner by neutralizing any acid that might already exist or be generated in the course of fermentation.

When gluten is kept in a moist state it slowly loses its soft, elastic, and insoluble condition; if kept in water for a few days, it gradually runs down into a turbid, slimy solution, which does not form dough when mixed with starch. The gluten of imperfectly ripened wheat, or of flour or wheat that has been badly kept in the midst of humid surroundings, appears to have fallen partially into this condition, the gluten being an actively hygroscopic substance.

Liebig's experiments show that flour in which the gluten has undergone this partial change may have its original qualities restored by mixing one hundred parts of flour with twenty-six or twenty-seven parts of saturated lime-water and a sufficiency of ordinary water to work it into dough. I suspect that the action of the alum is of a similar kind, though this does not satisfactorily account for the bleaching.

The action of sulphate of copper, which has been used in Belgium and other places for improving the appearance and sponginess of loaves, is still more mysterious than that of alum. Kuhlmann found that a single grain in a four-pound loaf produced a marked alteration in the appearance of the bread. Fortunately, this adulteration, if perpetrated to a mischievous extent, may be easily detected by acidulating the crumb, and then moistening with a solution of ferrocyanide of potassium. The brown color thus produced betrays the presence of copper. The detection of alum is difficult.

I should add that the ancient method of effecting the fermentation of bread, and which I understand is still employed to some extent in France, differs somewhat from the ordinary modern practice described in my last. When flour made into dough is kept for some time moderately warm, it undergoes spontaneous fermentation, formerly described as "panary fermentation," and supposed to be of a different nature from the fermentation which produces yeast.

Dough in this condition is called *leaven*, and when kneaded with fresh flour and water its fermentation is communicated to the whole lump; hence the ancient metaphors. In practice the leaven was obtained by setting aside some of the dough of a previous batch, and adding this when its fermentation reached its maximum activity. One reason why the modern method has superseded this appears to be that the leaven is liable to proceed onward beyond the first stage of fermentation, or that producing alcohol, and run into the acetous, or vinegar-forming fermentation, producing sour bread. Another reason may be that the potato mixture above described, which is but another kind of leaven, is more effectual and convenient.

Dr. Dauglish's method (patented in 1856, 1857, and 1858) is based on the fact that water under pressure absorbs and holds in solution a large quantity of carbonic-acid gas, which escapes when the pressure is diminished, as in uncorking soda-water, etc. Dr. Dauglish places the flour in a strong, air-tight iron vessel, then forces water saturated with carbonic acid under high pressure into this; kneading-knives mix the dough by their rotation. When the mixture is completed, a trap at the lower part of the globular iron vessel is opened. The pressure of the confined carbonic acid above forces the dough through this in a cylindrical jet or flat ribbon as required, and this squirted cylinder or ribbon is fashioned by suitable cutters, etc., into loaves. The compressed gas expands, and the loaves are smartly baked before the expansive energy of the gas is exhausted.

The difference between new and stale bread is familiar enough, but the nature of the difference is by no means so commonly understood. It is generally supposed to be a simple result of mere drying. That this is not a true explanation may be easily proved by repeating the experiments of Boussingault, who placed a very stale loaf (six days old) in an oven for an hour, during which time it was, of course, being further dried; but, nevertheless, it came out as a new loaf. He found that during the six days, while becoming stale, it only lost one per cent of its weight by drying, and that during the one hour in the oven it lost three and one half per cent in becoming new, and apparently more moist. By using an air-tight case instead of an ordinary oven, he repeated the experiment several times in succession on the same piece of bread, making it alternately stale and new, each time.

For this experiment the oven should be but moderately heated—130° to 150° is sufficient. I am fond of hot rolls for breakfast, and frequently have them *à la Boussingault*, by treating stale bread-crusts in this manner. My wife tells me that when the crusts have been long neglected, and are thin, the Boussingault hot rolls are improved by dipping the crust in water before putting it into the oven. This is not necessary in experimenting with a whole loaf or a thick piece of stale bread.

The crumb of bread, whether new or stale, contains about forty-five per cent of water. Miller says, "The difference in properties between the two depends simply upon difference in molecular arrangement."

This "molecular arrangement" is the customary modern method of explaining a multitude of similar physical and chemical problems, or, as I would rather say, of evading them under the cover of a conventional phrase.

I am making a few experiments which promise to afford an explanation of the changes above described, without invoking the aid of any invisible atoms or molecules, or anything else beyond the reach of our simple senses, and will communicate the results in my next paper.—*Knowledge.*

MY MONKEYS.

By M. J. FISCHER.

I HAVE never bought any trained monkeys, but, in my experiments in domesticating wild ones, have always treated my animals with the greatest care, and chosen moral rather than physical means of discipline. The relations between the monkey and his master ought to be friendly, and, when the first causes for fear and motives to anger have been suppressed, there will remain on the animal's part only feelings of respect. He will recognize his inferiority to man, and will respect him without fear. These lively and nervous animals, abruptly torn from their native wilds, to be shut up and treated in an unnatural manner, preserve in captivity their good-humor and intelligence to a remarkable degree.

The monkeys I have kept have been both of New World and Old World species. The last are the more intelligent.

In April, 1873, I received a young male of *rhesus* (*Macacus erythrœus*, or *rhesus*), well tamed, and weighing about three pounds and three quarters, but coming to me with a cold and in a very thin and dejected condition. His hair was lusterless, short, and all off in spots, while his tail was quite bare. He had, although a male, received the name of Molly, and answered to it readily. I did not change it. I gave him a cage large enough for him to turn around in freely, and to afford ample room for all the manifestations of his sanguine and nervous temperament. A few days after he came, I allowed him a brief promenade in the room. Without disturbing anything, he posted himself at a window, whence he could look at the passers-by. His conduct was so rational that I determined to extend his promenade, and shut him up only while I was away. This liberty, the constant intercourse with persons who caressed him as much as he would let them instead of teasing him, the quiet of his surroundings, and the removal of every feared and exciting object, exercised a decisive and favorable influence on his mental and physical development.

His attachment to me was extreme. He was near me all day, and followed me around like a faithful dog. When I hid away from him or shut a door in his face, he would cry and try to open the door with his hands, succeeding at last by throwing his whole weight upon the latch. In May my house was painted and whitewashed, and a scaffolding was built around it to facilitate the work. The top of the highest timber became Molly's favorite place. It was some four feet above the roof; Molly was accustomed to sun himself upon it, and from it he watched attentively all who passed. He would never move from it as long as he could see me. But, as soon as I set foot out of the grove where I used to work, he would set up a plaintive cry, and slide down the timbers to hunt me up, and would not stop his whining till he had found me, an event which he marked by repeated grunts of joy.

He gave me a proof of the susceptibility of the character of his species the very day he came. Perching himself on my wife's shoulders, he amused himself with disarranging her hair. Tired of this, my wife tried to push him away, at first pleasantly, then roughly. The last movement cost her a bite on the hand, and in return for this she struck Molly sharply on the cheek, when the monkey ran to his cage in great anger. From that day the inclination he had formed toward my wife was turned to a violent hatred, which he continued to manifest till the end of his days. All his affection was turned toward me, and it was really admirable. No dog ever showed so exclusive an attachment to me as this monkey, a fact the more singular because the animal had come from a wild life, and not, like the dog, from trained ancestors. Molly never refused morsels from the hand of other persons than myself; but, accepting the gift from them, he would scratch or bite the hand that offered it.

He was greatly frightened at a gun that I shot off one day at some sparrows. He hid at once in the straw of his cage, and never left it till the gun was hung up again. After that I had only to touch the stock, to make him hide again, when nothing could be seen in the straw, except a pair of sharp eyes watching all my motions. Just a touch of my finger or of a cane upon the cock of the gun was enough to deprive him of all quiet. I used to carry on my watch-chain a little pistol, on which a percussion-cap would make a tolerably loud report. The monkey had not yet found this out, and, sitting on my knees, would amuse itself with licking the silver barrel. One day in his presence I put a percussion-cap on the nipple of the pistol. The monkey observed my movements with great attention, but without seeming disturbed by them. But when the cock, being raised, made two clicks, Molly dropped his eyebrows, while he continued sitting quietly. When the explosion took place, his fright was unbounded. Crying loudly, and full of anguish, he fell from my knees, ran across several rooms, leaped out of the window, clung to a water-pipe, slid down to the street and hid himself in a ditch in a neighboring garden. His nervousness lasted a long while, and I had to take off my watch-chain to appease it. From that day he was in such fear of the little pistol that to take hold of the chain was enough to make him disappear in the straw. But he very soon learned by experience that the source of the detonation was not in the chain but in the pistol, and could easily distinguish it from the other appendages of the chain, of which he was not afraid at all. Sitting on the straw in his cage, he would attentively watch my movements while I was handling these appendages. The closer my fingers approached the formidable object, the greater became his anxiety, and with his eyes riveted upon the instrument and with tense ears, he would dance continuously in the cage, all ready to go under the straw. He would assure himself beforehand, for greater security, that the cage-door was well shut ; and one day, when the bolt had not been pushed in, he leaped out from the cage, which did not seem safe enough for him, and went and hid himself under the bed in the next room. As I gradually removed my hand from the pistol, I would receive chuckles of approbation ; and, with his lips pushed forward and the muscles of his ear moving by jerks, he would manifest a very great joy.

The conclusion is forced by these facts, that monkeys by experience become more prudent and more cunning. Carrying experiments of this kind further, I have observed that the monkey can recognize the object of its fear even in a picture, manifesting a faculty which is largely wanting in little children and savages. I one day received an armorer's illustrated catalogue. It had among other objects a drawing of a revolver of the natural size, an arm which the rhesus had never yet seen. I gave the catalogue to my pet, and he, after the manner of many monkeys, began to turn the leaves. But, as soon as he got to the picture of the revolver, he dropped the catalogue, groaned lustily and made faces, and at once ran to hide himself in the straw, which he would not leave till the pamphlet was taken away.

The last fact proves the superiority of simian intelligence over that of the other mammals. I disagree on this point from Perty, who says, "A small number of animals, among which is the elephant, recognize drawings of objects that are familiar to them." I must avow that my investigations on this subject, upon the few elephants living in Europe, have given me negative results. I do not know of any domestic animal that can distinguish a picture. It is useless to show dogs faithful drawings of the dog, or of game ; the result is nearly always the same. The animals will smell the paper, examining the substance, not the picture, and, once convinced there is nothing in it to exercise their teeth upon, they resignedly abstain from any more profound investigation. Monkeys, at least Old World monkeys, act differently.

The rhesus, a baboon (*Inuus ecaudatus*), three Java monkeys (*Macacus cynomolgus*), and a *sajou* (*Cebus hypoleucus*) were drawn in crayon for an illustrated magazine in pictures having a striking resemblance to the originals. I gave each monkey his portrait. The rhesus and the Java monkeys recognized the pictures at once, and acted precisely as if they were before a looking-glass. The rhesus grinned, then laughed, and at last turned his back to the picture, uttering grunts of satisfaction, as if he expected to be scratched. The Java monkeys stared at the picture ; with the skin of their foreheads drawn back, their lips pushed out and constantly moving, they regarded it from a distance and close up, to find out what it was. The other species likewise recognized the nature of the pictures, but without exhibiting as strong excitement as the two species mentioned. The least intelligent of the number was the sajou, which, examining the portrait from the head down and moaning, stretched its hand toward it, trying to tear it with his nails. Evidently it did not recognize the portrait either as one of itself or of another monkey, while it took in pictured insects very well, and was frightened at the sight of the painting or drawing of a viper. Notwithstanding these examples, I was careful not to generalize so as to extend to a whole species the faculties of a few individuals belonging to it. Among monkeys, as with man and other animals, there are individuals of extensive and individuals of very limited gifts in the same species. None of the many monkeys could distinguish pictures of landscapes or houses, in respect to which they were precisely like savages.

Only a few dogs give any signs of intelligence before their image in a glass. Some just distinguish it and remain quite indifferent ; others growl or bark, but they seldom try to determine whether a second individual really exists. I have remarked the same of cats, and Blanchard's cat in Paris, that dashed furiously at a looking-glass, is a unique example.

The rhesus looked into the mirror with a joyous air, stretched out his ears, drew up the skin of his forehead and his eyebrows, puckered his lips, grinned and laughed, and turned his posterior to the glass. This gesture is general among some kinds of monkeys. I had already described it as a peculiarity of a mandrill, when Darwin, having read my article, sent me a letter on the subject, asking me what significance I attached to it. I answered him that, according to my experiments, the gesture was a mark of simian politeness. Once in position, the monkey expects to be scratched, just as when we extend our hand to another person we expect to receive his. Darwin verified my observation, and compared the gesture with certain forms of salutation among savages, such as those by feeling the belly or rubbing noses. My rhesus, not succeeding in getting scratched by his image, turned around and passed his hand behind the glass to feel for it. I took the opportunity to pinch him sharply behind the glass, when he became very angry, not at me, but at the image. His face turned red, his ears were extended, and his jaws gaped open repeatedly. The gaping was so irresistible that he could not stop it, not even to chew or swallow. It is a sign of great anger and violent nervous disturbance. It occurs very frequently with the *pavions*, almost regularly, and the animal is often so overcome by its paroxysm that it can neither defend itself nor attack. Another sign of anger is given by shaking violently with the four hands the bars of the cage, the grating, or some support. This habit, born of the forest, is evidently intended to frighten enemies with noise. Molly never failed to exercise it when, after having been teased by any one, he heard him laugh. The cage was fastened to the table, and both were fastened to the wall. As long as the cage was loose, Molly would shake it. As soon as it was fixed, he tried to shake it, and, failing, did not do so again till time and use having worn upon the nails, the cage gained a little play, when he seized his opportunity and the racket was renewed. I then put in a piece of India-rubber to muffle the sound, and the monkey stopped his shaking. He did not care to see the cage move, but to make a noise. This habit is, however, not always a sign of anger. Some monkeys practice it under the influence of *ennui* or impatience, or when they wish to attract attention, and, in the lack of any other resource, the rhesus would hunt up in his straw a dry bread-crust, a nut-shell, a bone, or anything hard that he could strike against his cage-bars.

To express a desire, my monkey utters a prolonged "Oh!" or sounds the interjection in two syllables, with the second a fifth higher than the first. The tone rises according to the intensity of the desire. Thus, when I was talking with another person of the favorite eatables of the rhesus (such as milk, apples, potatoes, and rice), the monkey, although I was not speaking to him, underlined those well-known words with chuckles of approbation, and pushed his *oh's* through his lips, which were puckered out as if he were whistling. His attitude was the same when I gave the order from my room to have his meal brought in. The rhesus would at once fix his eyes on the door by which the anticipated feast was to come in; and this, no matter what might be the time of the day or night. The behavior was, then, not influenced by the periodicity of the want, which determines regular actions with many other animals, and was independent of the person who pronounced the words. I might cite thousands of cases observed on my premises, by hundreds of persons, that prove superabundantly that monkeys fully comprehend the relations of certain words and the objects corresponding to them.

The rhesus knew, besides, the names of all the animals that lived in the same room with him but in different cages—some sixty or seventy in number. If I pronounced the name of any of them, without giving any sign of voice or look, he would put his head through the hole in the cage, and turn it significantly toward the animal in question.

This monkey's fear of snakes was extreme, and extended to everything that had any resemblance to them. The same feeling is common to all monkeys. A very fine mandrill of my pets having a habit of prying about, I found no better way of restricting his investigations, which were sometimes annoying, than to put snake-skins under the objects I wished him to respect. The device succeeded admirably. It was to the same mandrill I once showed a prospectus of Semper's "Journey to the Philippine Islands," in which there was a picture of a holuthuria. At the unexpected view of this sea-horn, the mandrill made a jump and struck the ground with his hands, while his hair stood out and his body trembled from head to foot. The rhesus gave me a yet more striking example of this horror. I had received a large python, which I had brought into the room every day for a warm bath. After nine days, I had only to call out, "Bring in the serpent," for the monkey to disappear under the straw. Long after the serpent had been restored to health and the baths had been discontinued, the repetition of the order would set Molly a-trembling at any time.

Perty says that dogs are the only animals capable of reading human physiognomy; but one has only to possess monkeys and be acquainted with them to know that they too can read it better than children can. I except New World monkeys, which have little or none of the faculty. I had a little female Java macacus, of an exceedingly pleasant and timid nature. I had only to raise my voice in speaking to her, to arrest all her motions. When I returned into the room, she would follow me with her eyes, trying to read the expression of my face, and endeavoring to gain my sympathy by a low murmuring, going away or coming up to me according to the play of my features. If she saw me smile she would make a sound of gladness, clasp my knees and press against me, with murmuring lips and eyes gazing into mine. But, at the first frown or hard look, the macacus would drop down crying and run away. The rhesus responded in a somewhat similar manner to my expressions.

Monkeys have a passion for cleanliness. Once on your knees, they will pick you from head to foot, not letting a wrinkle escape, and all with the most serious air. My rhesus could not endure badly dressed persons. He was always ready to defend me, and to spring upon any one who would touch me with the tip of his finger. He had no respect for children, but acted as if he took them to be large monkeys, and would sometimes attack them when they were too saucy. Some of the other monkeys, however, seemed to be quite fond of them. The rhesus appreciated the inferiority of my servants to myself, and would become angry at any one of them when I reprimanded him, his anger being modulated according to my tone, and sometimes leading him to acts. He co-operated in all my gestures when I acted as if I were beating a man or a dog, but if it were another monkey that was threatened he took its side. The feeling of compassion is not strange to monkeys. They will defend and protect threatened individuals, sometimes offering their own bodies as a shield. They extend their commiseration to animals of another species. The rhesus became furious when he saw the ferret, in the course of his training-lessons, biting rats, and, taking him by the tail, bit him to save the rat.

The rhesus slept at first perched on the bars of his cage, but soon learned to accustom himself to easier positions. He could cover himself up with the quilt, and would finish by drawing it over his head with his teeth. He often had lively dreams. I could see him grin, and hear him utter low but distinct sounds of comfort, of desire, and sometimes of fright. In the latter case he would always awake, jump to the highest stick, and cast frightened looks around.

His obedience was complete, and was never wrecked except upon the rock of gluttony. If I left any delicacy on the table, he would never touch it when I was looking on ; but, after my back was turned, nothing of it could be found. I could not contend with this fault except by stratagem ; but to put a stuffed snake-skin by the side of the coveted object was always enough to secure its protection.

The feeling of the right of property is common to all monkeys. I gave a red quilt to a Java macacus and a blue one to another macacus. Each one was jealous of his own garment, and the least infringement by one on the proprietary rights of the other was followed by a battle.

Perty says that monkeys can untie knots, but can not tie them. Is this a mark of inferiority? Monkeys, like other animals, have for most of their actions a determined object. My rhesus was obliged, to get honey, to open the closet and, to be at liberty, to untie the rope. He did both. But why should he shut the door, or tie the rope again? Do we not have to teach children and boors to shut doors?

Monkeys can estimate weights. I gave the rhesus full eggs and empty shells, between which there was no difference to the eye. At first he bit both alike, but he soon learned to throw the empty shells away without biting them. I continued the egg experiments by filling the egg-shells with iron filings, lead, sawdust, and sand. After several trials, he never could be deceived except by eggs of the same density as normal ones. This faculty is not, however, equally possessed by all monkeys.

It can not be denied that monkeys have some, but a weak, notion of number. My rhesus was accustomed to get a certain number of carrots, or apples, or potatoes, and, if his ration fell short, he would always take notice of the deficiency. If he got only three apples when he was expecting four, he would not move from the grating till the fourth apple was brought him. Music had but little effect upon him ; but the sound of a hunting-horn would send him under the straw, and cause him to scratch his ears as he would do when one was driving a nail near him. Nothing delighted him more than to have a lighted cigar or pipe in his mouth. He would fill his cheek-pouches with the smoke and send it out through his nostrils like any expert at the cigarette.

The anecdotes about the propensity of monkeys to imitate man are much exaggerated. They have a physical structure like his, and mental qualities in some respects not wholly dissimilar from his, and naturally make gestures like those of men ; and that is the most of truth there is in those stories.

Monkeys have a language, as among themselves, that is easily understood by individuals of the same species. Individuals of different species, if not too far remote, can after a time learn to understand each other ; but if the species are very different, like those of the Old and the New World, the effort is tantamount to that of learning a new language, and frequently requires several years. As the thoughts of monkeys are excessively limited in extent and their wants relate solely to food and the struggle for existence, their language is but little varied, and is composed chiefly of vowels pronounced with different intonations and accompanied by different expressions of the figure, the most common of which are laughing and grinning, and which each species performs in its own peculiar fashion. The expressions of anger are also characteristic, and vary with the species.

My rhesus, together with a large mandrill and a *Cynopithecus niger* of unusual size, ate at my table, and received all the dishes that I had. The rhesus preferred roast fowl and roast mutton to all other meats, and also liked eggs, raw or cooked. His weakness for eggs once cost me a considerable sum, which I had to pay to a neighbor for one hundred and fifty eggs of high-bred fowls which my pet had destroyed. He ate all kinds of seeds, and liked much to vary his food. Among vegetables he preferred asparagus, and had a strong appetite for fruits, to gratify which he made my own and my neighbors' orchards suffer.

His ordinary drink was milk and half a glass of Bordeaux, which he took in his hand as a man would have done, without spilling a drop. I sometimes gave him tea, chocolate, cocoa, coffee, beer, and white Tokay wine. He frequently abused the last drink, and learned to go into a room where a bottle of it was kept. He would then get drunk —dead-drunk—like any man, and my servant would find him and call to me to help put him into the cage. But, even in this condition, he never failed to have a degree of respect for me, though he would resist being moved, as the street-toper resists the policeman. Put in the cage, he would sleep off his draught stupidly, and then be sick for two or three days, obstinately refusing to eat anything, but never to drink.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE SALT-DEPOSITS OF WESTERN NEW YORK.

By FREDERIC G. MATHER.

WYOMING County, in the State of New York, is bounded on the southeast by the wonderful gorge that has made famous the mighty leaps of the Genesee River at Portage. A few miles to the north is the plateau which holds the crystal waters of Silver Lake; while still farther to the north and west rise the head-waters of Oatka Creek, which flows in a northeasterly direction through the county of Genesee, and empties into the river of that name just before it comes to Rochester. The Oatka was formerly called Allen's Creek, after a resolute pioneer. The valley and the county were named Wyoming, from a striking similarity to the valley in Pennsylvania which once received the murderous visit of the savage, and which has been immortalized in the verse of Campbell. Warsaw, the shire-town of Wyoming, most romantically situated near the source of the creek, was called by the Indians "Chi-nose-heh-geh," or "on the side of the valley." The village of to-day numbers but twenty-five hundred inhabitants, although the region all about has been settled nearly one hundred years, and although a prominent railroad skirts the valley on either edge. All about is a most excellent farming-land, second only to the Genesee Valley. The butter and cheese are of the best quality, and they find a ready sale in Buffalo or in Rochester, either metropolis being less than fifty miles away. This valley, hitherto so peaceful, is now the center of a business activity that bids fair to be permanent, and that will reduce by one the number of staple articles for which the United States has hitherto depended upon foreign countries.

Over forty years ago extensive surveys were made from Oswego to Niagara, and salt-springs were found in many places. In the hollows toward Lake Ontario the brine was discovered in such quantities as to make unnecessary any additional salting of the cattle that were pastured in the vicinity. It was also discovered that salt might be found at the south of this belt, but not without considerable boring. No one, however, suspected that the valley would yield salt as far up as Warsaw. Therefore, when the Vacuum Oil Company, of Rochester, commenced to bore for oil at Wyoming, just north of Warsaw, the enterprise was thought to be only a natural extension of the oil-fields of Pennsylvania, which lie fifty miles or so to the southward. The man who directed the boring had been a boy in the Wyoming Valley, and he had enough faith in the existence of oil to lease the neighboring farms for ninety-nine years, with the agreement that he would put down a test-well; that, if successful, a well should go down on every man's farm; and that the owner of the farm should have one eighth of the product in every case. Oil was not found, but brine came up in sufficient quantities to show that the salt was there. The treasure was allowed to remain undisturbed until two years ago, when a well was sunk in Warsaw to a depth of thirteen hundred feet, where a bed of salt eighty-five feet thick was encountered. From this bed the Warsaw Salt Company has been drawing one hundred and fifty barrels of brine daily for the past year. Two miles below this is the well of the Crystal Salt Company, which, starting with a daily yield of fifty barrels, has now reached several hundred. On the eastern slope of the valley extensive works have been erected by Dr. Guionlock, who has had thirteen years' experience with the salt product at Goderich, in the Province of Ontario, and who prefers the Warsaw product to the other. Across the valley, on the western slope, is the well of another Warsaw company. In short, there are, within a radius of three miles of Warsaw, seven wells already down and three more in process of digging, the output of which when completed will be three thousand barrels daily, the output at Syracuse being but five thousand barrels daily.

The unexpected treasures found at Warsaw have added hundreds to its population, have increased real estate fifty per cent, and have secured a new railroad, the "Oatka Valley," in addition to the Rochester and Pittsburg, and the New York, Lake Erie and Western, and the Lehigh Valley, which are already there. The newly-laid tracks of the New York, Lackawanna and Western are only a dozen miles away. The hill-sides are covered with hard-wood timber, which can be converted into barrels. With this bright outlook it would not be strange if the people of Warsaw should picture to themselves a future labyrinth of salt-mines that might rival that of Austrian Galicia, with its saline church dedicated to St. Anthony. Even at this stage of the enterprise the men of Warsaw are said to keep one of their number on guard at the arrival of every train, lest some prospector should stray as far down the valley as Wyoming, Pavilion, Covington, or Le Roy, or even over the ridge to Greigsville. If they have their own way, no other spot aside from Warsaw will share in the benefits of the discovery ; and from his elevated post on the magnificent soldiers' monument the stone sentinel will gaze defiantly on the surrounding towns. In such a case the poet sang of the sentinel as well as of Kosciusko :

> "Warsaw's last champion from her heights surveyed,
> Wide o'er the fields, a waste of ruin laid."

But are the men of Warsaw to have, what they naturally desire, a monopoly of the new salt production? It is evident that the average depth of the salt-bed thereabout is eighty feet, and that the depth of boring required to reach the bed becomes less as the prospector travels north. This southerly dip has given hopes to the dwellers about Rochester that the bed will be found much nearer the surface at that point—a fact that would lead to cheaper production, even if the thickness of the bed were less. Then, too, the dwellers east and west of the meridian line, upon which are located most of the wells bored thus far, are confident that salt will be found many miles away from the said line, and they have started "pointers," after the manner of the oil-country, to mark the limits of the territory. The geologists affirm that all the salt of Syracuse, Warsaw, Saginaw, and even of Wisconsin and Iowa, belongs to the Onondaga salt-group, and that it was deposited all over this extensive tract in a chain of land-locked lakes fed by occasional overflows from the ocean, and depositing their saline contents by evaporation. A similar process is now going on at the Runn of Cutch, of which Sir Charles Lyell says: "That successive layers of salt might be thrown down, one upon another, over thousands of square miles in such a region, is undeniable. The supply of water from the ocean would be as inexhaustible as the supply of heat from the sun for its evaporation." This theory will explain why the dip of the salt-strata of Western New York, added to the natural rise of the ground, makes a boring of fifteen hundred feet necessary at Warsaw, while at Salina a depth of only two hundred feet is required.

In this fact of the strata coming nearer the surface to the northward of them lies the danger to the hopes of the people of Warsaw. In many other respects they are warranted in believing that they have a bonanza. The "pointers" that have been already sunk and the unsuccessful experiments that have been made in former years show that the beds of rock-salt do not extend farther north than Caledonia, in Livingston County, nor farther south than Castile, in Wyoming County. The narrow strip within which the beds are confined runs from Onondaga County, on the east, through the counties of Cayuga, Seneca, Yates, Ontario, Livingston, and Wyoming, to Erie on the west.

The claim that the sign "Warsaw salt" represents a superior article appears to be well-founded—the brine having been analyzed with flattering results by Dr. Lattimore, of Rochester, and Dr. Englehart, State chemist, of Syracuse. The latter reports the specific gravity to be 1·205. The analysis of 100 parts is as follows: Sulphate of lime, ·257; chloride of calcium, ·068; chloride of magnesium, ·005; chloride of sodium, 26·300; pure water, 73·370. The exceptionally small proportion of the chlorides of calcium and magnesium will be noted, as well as the large proportion of pure salt which the recent superintendent of the Syracuse salt-springs declares entitles the Warsaw brine to rank as 100 to 66 for the Syracuse brine. An analysis of the manufactured article shows the following results:

	Warsaw salt, No. 1.	Warsaw salt, No. 2.
Soluble matter	0·104	0·013
Moisture	1·500	0·753
Sulphate of lime	1·464	0·955
Chloride of calcium	0·136	0·089
Chloride of magnesium	0·298	0·118
Pure salt	96·498	98·072
Total parts	100·000	100·000

It is stated that the superior strength of the Warsaw brine makes it possible for one ton of coal to produce more salt, by sixty-four cents' worth, than can be produced from the Syracuse brine. This fact, together with the falling off in the Syracuse output, has called marked attention to the Warsaw wells.

The product of salt from the Michigan wells is over 15,000,000 bushels annually, on which the profit is large because the fuel consists of slabs and sawdust, a mere nothing. An eminent authority—Dr. Mitchell—states that there are three sources of the salt-supply in Michigan: 1. In the coal-measures and in the white and porous Parma sandstone, which serves as a reservoir. 2. The "Michigan Salt-Group," which lies between the carboniferous limestone and the sandstones at the base of the carboniferous system. This group consists of various shales, magnesian limestone, and beds of pure gypsum. The material of the reservoir is Napoleon limestone. The depth of boring is 600 to 700 feet, and the total area of the territory is about 17,000 square miles. 3. The "Onondaga" or Salina Salt-Group, which lies 500 feet below the Michigan Salt-Group, and in which alone are found the beds of rock-salt. The most important well is that at Marine City, on the St. Clair River, the total depth being 1,633 feet, and the thickness of the salt-beds 115 feet. The well at Muskegon, on Lake Michigan, is 2,000 feet deep, and the thickness of the salt-beds is 50 feet. Other important wells are operated at Bay City and at Manistee.

Similar beds are found in the Province of Ontario, at Goderich, Huron County. They are in the Salina formation also, the depth averaging about 1,000 feet, and the thickness of the salt about 30 feet. Exceptionally deep wells have been driven to a depth of 1,600 feet through six layers of salt aggregating 125 feet in thickness. The salt area of Canada is estimated at 2,000 square miles, and the probable quantity of salt still in the beds is called 200,000,000,000 tons. The Canadian salt is superior to the Michigan salt in regard to the absence of the earthy chlorides, as the following analysis will show:

	Goderich Salt.	East Saginaw Salt Company.
Sulphate of lime	0·989	0·317
Chloride of calcium	0·134	0·356
Chloride of magnesium	0·124	0·141
Insoluble	0·037	0·000
Moisture	1·396	3·344
Loss	0·016	0·000
Pure salt	97·304	95·842
Total parts	100·000	100·000

The salt-beds of Michigan underlie each other like a nest of saucers—the oldest being in the old dolomite limestones in the ancient

Devonian ocean. Here alone we have the beds of pure rock-salt. As we come nearer the surface, the presence of the earthy chlorides is more marked, and the product is less valuable, because, by reason of its attracting more moisture from the air, it is rendered unfit for the dairy or the table unless it goes through a process of purification. The conclusion that we must reach, therefore, is, that the deeper the boring goes, the purer the salt will be, whether it is in Michigan or in New York. Following out the logical deduction of this conclusion, we must admit that while the outcroppings of salt toward the northern edge of the New York field might offer superior inducements in the way of securing the brine, yet the brine when secured would be so much weaker and more impure that the decreased cost of producing it would be more than offset. In other words, the brine that is reached at a depth of two hundred feet north of the Warsaw Valley offers no superior advantages to that which for many years has been reached at a similar depth on the reservation of the Onondaga Salt-Springs. In deep boring and pure salt lie the best hopes of the Warsaw product.

The relative value of brine from the various salt-producing localities is shown by the following table, which gives the number of gallons of brine required to make one bushel of salt :

Sea-water	300 to 350
Boone Lick, Missouri	450
Conemaugh, Pennsylvania	300
Jackson, Ohio	213
Lockhart's, Mississippi	180
St. Catharine's, Ontario	120
Zanesville, Ohio	95
Grand River, Arkansas	80
Kanawha, West Virginia	75
Montezuma, New York	70 to 50
Muskingum, Ohio	50
Onondaga, New York	45 to 30
Saginaw, Michigan	30 to 25
Goderich, Ontario	22
Warsaw, New York	20

Not only is it claimed that the Warsaw salt is superior to any other for the packing of meats and the uses of the dairy, but also that it is the sole product in the United States from which soda-ash can be manufactured. This article is used for bleaching, dyeing, soap-making, and several other processes. Hitherto it has been imported to the value of millions of dollars yearly, because no brine of sufficient strength could be found in the United States. Attempts to use the brine of Canada and Ohio have utterly failed. At last the brine of Syracuse was tried, and it was found that by being chemically treated and salted it would serve the purpose. Large amounts of capital are already invested in the strengthening of the Syracuse brine ; but it is found that the Warsaw brine is strong enough to be used without any chemical treatment. Large investments, therefore, are making, in the Wyoming Valley, for the manufacture of soda-ash; and the success of these manufacturers will make the United States independent of every other country in regard to this commodity. Of course, the salt-men of Warsaw are as clear-cut protectionists as are their fellow-workers of Syracuse or Saginaw. The duty on foreign salt is eight cents per hundred, or twenty-two cents for a barrel of two hundred and eighty pounds. They argue that salt having dropped from one dollar and eighty cents a barrel in 1860, to seventy cents in 1882, the saving of one dollar and ten cents on a barrel has been an aggregate of seven million dollars to the people of the United States. To remove the tariff, they affirm, would be to raise the price, to shut down home industries, and to allow foreigners to make the money that should be kept in this country.

The outward appearance of a salt-well in the Wyoming Valley does not differ materially from that of a well in the "oil-country." We see the same derrick, of spruce or hemlock; the ponderous wooden walking-beam, half out-of-doors; the "bit," the "auger-stem," and all the other appliances for boring, together with the "pull-wheel" that hoists the whole apparatus from the hole; the forge hard by; the "sand-reel" that lowers the pump for clearing away the pulverized rock; and the "fishing-tools" and all other tools for clearing the well of bits of broken apparatus. A short distance from the derrick is a covered shanty which contains the engine, while the boiler is still farther away, and generally in the open air. With such an apparatus, the cost of boring is from seventy-five cents to one dollar per foot for operating expenses. The workmen serve in gangs—two for each twenty-four hours—and the wages are one dollar and fifty cents per day. The drill first strikes through thirty feet of heavy clay; then fifteen feet of slate or Marcellus shale; then one hunded and fifty feet of corniferous limestone; then fifty feet of hydraulic limestone; then about twelve hundred feet of saline shales, at the bottom of which is a stratum of salt averaging eighty feet in thickness. Still below this are the Niagara limestone and other members of the Niagara group.

The stratum of salt having been once pierced, a saturated solution of the saline matter frequently rises in the boring to within eighty feet of the surface. This, however, can not always be depended upon —and here center the increased difficulty and expense. When a few dozen feet have been drilled, a six or an eight inch iron pipe is inserted as a "casing." Inside of this a two-inch pipe—also of iron—is placed. The "casing-head" has two openings—one for the entrance of pure water from a neighboring spring into the larger pipe, at the lower end of which it becomes saturated with saline matter; the other at the end of the smaller pipe, to allow the expulsion of the brine. Of course, the wells become foul or leaky at times, and then resort is had to torpedoes of nitro-glycerine, which are sent down to the bottom of the "casing," and after them is sent an iron weight which secures the explosion. The rusting of the "casing" is the great enemy of the salt-worker; and, when his engine can not lift the mass of rusted iron, a "knife" cuts the rusted metal, and the engine tears it away piecemeal. But the salt-wells are exempt from any danger of taking fire; and it is never necessary, as in the case of oil-wells, to shoot off the "casing-head" with a cannon-ball.

After the brine has once reached the surface it is forced into large reservoirs, whence it is drawn off through "string" after "string" of "covers," until solar evaporation has left the coarser grades of salt. The "covers" or vats are usually sixteen by eighteen feet, and the product of each one per year is estimated at one hundred and fifty bushels; while the product at Syracuse is only about half that quantity. It is also claimed that the slope of the valley at Warsaw is peculiarly adapted to rapid evaporation by the sun. When the finer grades of salt are wanted, the brine is led from the reservoirs to an evaporating-pan, where a gentle heat is applied. Similar treatment in another pan completes the process, and the residuum of salt is raked upon a shelf at the side of the evaporator. After a slight draining it is taken to the bins, where a more thorough draining is allowed for a space of two or three weeks. The heat is applied to the evaporating-pans through steam-pipes, in the same manner that has been found most economical both at Saginaw and Syracuse. At Saginaw the fuel costs next to nothing, as it is the refuse of the lumber-mills; and the exhaust steam of the mills is also used for the pipes of the evaporating-pans. At Syracuse and at Warsaw the expense for fuel is greater, Warsaw using anthracite coal-dust, or "culm," at an expense of one dollar and sixty-five cents per ton. Whence, then, does Warsaw derive its hope for successful competition against Syracuse and Saginaw? The ever-ready answer is, that the strength of brine at Syracuse is sixty-six to one hundred at Warsaw—a difference that makes the cost of fuel twenty cents per barrel for Syracuse as against eight cents for Warsaw. In regard to the Saginaw brine, also, it is claimed that its residuum after evaporation is ninety-seven per cent of pure salt; while that of the Warsaw brine is one hundred—a difference which, if sustained, would amply cover the increased cost of fuel at Warsaw. The salt-men of Warsaw, too, have the greatest confidence that their borings for natural gas will result in giving them a fuel even cheaper than culm. The Warsaw men also declare that their own enterprises are on private land; and that they, therefore, have an advantage of the salt on the Syracuse reservations, every bushel of which must pay half a cent per bushel to the State. And they do not fail to call attention to the fact that the duty was one cent per bushel before the borings at Warsaw had proved a success. In short, they see no reason why Warsaw should not furnish a large share of the six million barrels of home-made salt that are required every year, even if Syracuse gives a million and a half and Saginaw three and a quarter millions toward the product.

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

CARE OF OTHERS AS A DUTY.

I ENTER now on a portion of my subject where I shall seem less at issue with those who repeat with their lips, and fancy they hold in their hearts (though they never think of following in their lives), certain rules of conduct in which due care of self is treated as objectionable and evil is spoken of as not to be resisted but encouraged. I shall still be at issue with those who assert, apparently without thinking—certainly without alleging any reasons—that conduct and duty are not matters for scientific discussion at all, that they have no scientific aspect, and that such considerations as the progress and improvement of life, the increase of the fullness and happiness of life, and so forth, have no bearing whatever, and should have none, on our opinion as to what is right or wrong. But we may very well afford to disregard objections having so little relation to actual facts. Every one really guides his conduct in large part by such considerations as many thus allege to have no proper bearing on conduct; nor can any one draw a line beyond which such considerations must not operate: when any one has tried to do so, and perhaps imagines he has succeeded, then I shall simply meet his objection with the remark that he need consider what I have said and what I may hereafter say as only applying to such parts of conduct as he has admitted to be within the range of scientific discussion.

Let us take, now, the doctrine that while due care of self comes to each man, and indeed to every creature having life, as essentially *first*, yet due care of others—though second to due care of self—is as absolutely essential. The two are interdependent—and that to such degree that neither can exist without the other. The great difference in the treatment which science has to extend to the two forms of duty—the egoistic and the altruistic—resides in this, that whereas in insisting on egoistic duties science is really insisting on what every normally-constituted man is already apt to attend to, in insisting on altruistic duties science is insisting on duties wofully neglected, despite the fervor with which they are verbally enjoined. Many reject egoistic duties in words, who look so carefully after their own interests in action that those who inculcate due care of self as a duty are ashamed to have to admit such utter selfishness as among the results (the unwholesome fruits, as it were) of the process of development which conduct, like all things else, has undergone, is undergoing, and will ever continue to undergo. The truth is, that the careful study of what may be rightly sought and claimed for self is no unworthy preparation for due thought and care of others.*

Let us briefly trace the development of altruism.

In many of the lower forms of animal life, the acts which tend to race-maintenance are altruistic. The parent is sacrificed wholly or partially in the production of progeny. Nor even in the higher forms of life does this form of sacrifice disappear, though the very beginning of new existences may involve egoistic rather than altruistic relations. Unconsciously at first, but consciously afterward, and later still by definite actions to that end directed, the mother of each new member of even the human race divine sacrifices herself for her offspring. We may be said to imbibe altruism with our mothers' milk. Every act by which in babyhood our life was fostered was a practical exemplification of the doctrine that care of others is essential to the maintenance and progress of the race. To altruism each one of us owes life itself, and the human race owes its existence as certainly to altruism, though such altruism was secondary to egoism in its influence.

And note here, in passing, how development of conduct is related to this early altruistic care of the individual life. As certainly as a want of due care of self leads to the diminution of altruism, by causing those who are not duly egoistic to disappear from the scene of life and leave no successors or few, so does want of due care of others, in the nourishment and rearing of offspring, lead inevitably to the diminution and eventual disappearance of types not sufficiently altruistic. The careless, unloving mother is unconsciously doing her part in eliminating selfishness from the world (the process, however slow, is a sure one), for the child she neglects shares her nature, and must thrive less than a child of happier nature nursed and cared for by a more loving mother. In whatever degree individual instances may seem to tell against this process of evolution, in the average of many cases and through many generations the law must certainly tell.

Nor is this law limited to the influence of the parent who has most to do with the earlier years of life. Throughout childhood and in greater or less degree to the hour and even beyond the hour when each man and each woman begins to take part in the duties of life, and in most cases in the actual struggle for life, development depends on cares which will be well bestowed by unselfish parents, and so tend to increase the amount and fullness of unselfish life, while the selfish will neglect them, and so unconsciously help to eliminate (in the long run) the more selfish natures. It must be so if there is any truth in

* Even the doctrine so many preach but so few practice, "Care for others as for self," would be somewhat unsatisfactory if our care of self was insufficient; it ought, then, to run, "Neglect the rights of others as you are careless of your own."

the doctrine of heredity, and the doctrine is not only true but is universally recognized: it is scarcely more clearly and certainly recognized now than it was by those who in old times made the pregnant proverb, full of old-world wisdom and experience, "The fathers have eaten sour grapes, and the children's teeth are set on edge." Fathers and mothers who are selfish by nature rear with less care offspring who as certainly inherit their nature as the young of beasts of prey inherit the carnivorous tastes of those to whom they owe their lives. Hence, fortunately for the race—seeing how many egoistic tendencies are apt to be fostered in the struggle for life—a constant tendency to the elimination of the more selfish natures.

To this may be added the consideration that the ill-reared and unduly egoistic are less likely than those of more generous and altruistic nature to be found pleasing by those of the opposite sex, less likely therefore to marry, so that (speaking always of the average not of individual cases) there is yet another factor opposing the increase in number of the unduly egoistic.

Thus do we recognize on the one hand that within families a due degree of altruism is essential to the development of life and life's fullness, while on the other hand undue egoism tends directly in more ways than one to diminish happiness.

The best proof that such influence is exerted is found in the circumstance that in every advancing community the young are cared for with constantly-increasing care. Among savage races offspring receive few altruistic attentions. They are not reared in the full sense of the word. Almost from the beginning of their lives they have to take part in the struggle for life. In civilized communities they are cared for during many years, and they are better, more thoroughly, and more wisely, cared for, the more such communities advance. All this indicates and enables us to measure the development of altruism, so far as the family is concerned.

And that care of others in this case (i. e., within the family) is not only essential to the development of life and its fullness, but also to the happiness of self, will be clear if we consider the matter with the least attention. For the altruistic nature shown in the care of children is inherited by children and developed in them by such care. Hence, as Mr. Spencer well notes, there results such conduct on the part of children as "makes parenthood a blessing." Of the parent of children inheriting such natures and so reared, it may be said that, even in our days (to which the saying of the Hebrew Psalmist was not, I suppose, intended originally to apply), the man is blessed that hath his quiver full of them.* On the contrary, where the parents and therefore probably the children are of selfish nature, and the example set the children is unduly egoistic, parenthood is no blessing, and may well

* So only that it be not so full as to give the little arrows but a narrow space to turn in; for so can not the young idea be daily taught to shoot.

become a source of misery. What happens in this case? asks the philosopher whose treatment of the scientific aspect of duty we are following. "First the domestic irritations must be relatively great; for the actions of selfish children to one another and to their parents cause daily aggressions and squabbles. Second, when adult, such children are more likely than others to dissatisfy employers, alienate friends, and compromise the family by misbehavior, or even by crime. Third, beyond the sorrows thus brought on them, the parents of such children have eventually to bear the sorrows of neglected old age. The cruelty shown in extreme degrees by savages who leave the decrepit to starve is shown in a measure by all unsympathetic sons and daughters to their unsympathetic fathers and mothers; and these, in their latter days, suffer from transmitted callousness in proportion as they have been callous in the treatment of those around. Browning's versified story 'Halbert and Hob' typifies this truth."

We turn next from altruism in the family to altruism as an essential part of social conduct.

The relations within a family present on a small scale a picture of the relations among the members of a race or nation, as these in turn present a miniature of the relations between the different races and nations which form the human family. As men rise in the scale of being, they pass from the sense of duty within the family to the sense of duty between man and man throughout society, and thence—though as yet this development is very limited—to the sense of right between different races and nations. We have seen that undue care of self is self-injurious and eventually must be self-destructive in the family. There is a corresponding law for undue care of self in social relations, as there is (however persistently at present the vast majority of men overlook or fail to see the fact) for undue regard of self among the nations. We may mistakenly regard undue care of self in the body social as cleverness, aptitude for business, and so on; and we may mistakenly regard national selfishness as patriotism: but the process of evolution is as certainly working toward the elimination of one as of the other form of undue egoism.

The main condition of social welfare and of social progress is that the union which society implies shall work for the benefit of those associated. If the balance of effects resulting from association be evil, the body social must inevitably dissolve in the long run.

Now, by laws of greater or less severity the members of a race or nation may be compelled to recognize each others' claims. Or such recognition may be assured by the fear of retaliation if the claims of others are neglected. In such cases, however, the gain to each, or the egoistic advantage of association, is small. Enforced recognition of altruistic rights is in itself disagreeable. The more disagreeable it is the oftener will cases arise where the laws have to be called into operation (and their operation is by our supposition painful), or where retaliatory action is aroused, with waste of energy and disagreeable effects on either side. A society so restrained is held together by but weak bands, and is ill fitted to support itself against external enemies. Internal co-operation for the benefit of the community can not be active under such circumstances. The products of labor are insecure. Moreover, whatever has to be done in the way of self-protection or of the safeguarding of property is so much withdrawn from the advancement of the general interests of the body social.

We have only to consider the condition of any European country, our own included, in the good old times which so many ignorant persons regret as a sort of golden age, to see how unsatisfactory must be the state of a nation in which only a stern code of laws, or the dread of retaliation, protects each against the undue egoism of his fellows. Internal wrong-doing and the necessity for constant struggle to resist such wrong-doing made each nation unstable. Our good old England was invaded and conquered over and over again in consequence of instability so produced. From long before the invasions by Saxon hordes under pirate chieftains to long after the invasion by Normans under the bastard descendant of the pirate chief Rollo, England was made wretched and miserable by constant contests, having their origin invariably in that undue egoism which we now call rapine and plunder. None—not even the most powerful—were secure. The castles we find so picturesque and romantic, the battles which seem glorious, the chivalry in which we see so much splendor, all tell us of a state of barbarism, of abject misery for the majority, of magnificent discomfort for the powerful. In the unsafety of those days, however, resided the certainty that the undue egoism of "the good old times" would by a natural process of evolution be eliminated. It is not yet fully eliminated; probably centuries will elapse before it is even in great part got rid of; but it is manifestly much reduced. We still have laws to protect us against wrong-doing, but the worst wrong-doers—those who of yore were the principal component parts of the body politic—no longer exist in the same way as of old. A much larger proportion of the social body recognize regard for others as a duty; no inconsiderable proportion recognize it as a pleasure; and, what is of more importance still, men recognize the advantage of encouraging these changed tendencies.

These changes have come on so gradually that few consider how important they really are. It is not too much to say that a large proportion of the Englishmen of our day would find life not worth living if the old state of things were restored; if, for instance, life and property and reputation became as insecure now as in the days of the Plantagenets, the Tudors, or even the Stuarts.

And here it may be noticed that those who neglect the consideration that they form part of the social body and refrain from the taking due part in maintaining a healthy social state suffer from the defective arrangements which they permit to remain uncorrected. We see this in very marked degree in America, though it can be recognized clearly—far too clearly—in our own country. There the best men keep out of politics for a reason which rightly understood should make all the best men take most anxious interest in politics. Because in America offices are too often filled by mere adventurers, because bribery and corruption are rife, and because fraudulent conduct is common among politicians, therefore should it be held the duty of every right-minded American to do his best to enforce the wholesome changes so obviously required—as they might be enforced if so many of the best Americans were duly altruistic. But as a matter of fact the very circumstance which should arouse all the best in America to vigorous action is made the chief reason for withdrawing from public duties.

In our own country the same undue egoism shows itself in another and a scarcely less mischievous form. The individual members of the community find relief in the thought that social duties may be handed over to government. It seems easier to talk laws into existence for getting things done than to do them. The laws are easily passed, but the doing of what is necessary passes in a great number of cases into the hands of men not nearly so much interested in the doing of it as those who passed the laws appointing them to the work—nay, often by the very nature of the laws so passed, interested rather in delaying than in pushing on the work.

As Mr. Spencer well puts it, the man who thus shirks the duties which he owes to the community of which he forms part, who plumes himself on his wisdom in minding his own business, "is blind to the fact that his own business is made possible only by maintenance of a healthy social state, and that he loses all round by defective governmental arrangements. When there are many like minded with himself—when, as a consequence, offices come to be filled by political adventurers, and opinion is swayed by demagogues—when bribery vitiates the administration of the law and makes fraudulent state transactions habitual; heavy penalties fall on the community at large, and among others on those who have thus done everything for self and nothing for society. Their investments are insecure; recovery of their debts is difficult; and even their lives are less safe than they would otherwise have been. So that on such altruistic actions as are implied, firstly in being just, secondly in seeing justice done between others, and thirdly in upholding and improving the agencies by which justice is administered, depend, in large measure, the egoistic satisfactions of each."

Apart from dangers directly affecting life and property, those resulting from undue egoism in business relations show the necessity of just altruism for the welfare and happiness of the social body. Not only is it well for each to recognize the rights of others, but each is interested in securing due recognition of altruistic rights by his fellows. The evils resulting from business frauds affect the welfare of the community. To quote the illustrative cases cited by Mr. Spencer, "The larger the number of a shopkeeper's bills left unpaid by some customers, the higher must be the prices which other customers pay; the more manufacturers lose by defective raw materials or by carelessness of workmen, the more must they charge for their fabrics to buyers. The less trustworthy people are, the higher rises the rate of interest, the larger becomes the amount of capital hoarded, the greater are the impediments to industry; the further traders and people in general go beyond their means, and hypothecate the property of others in speculation, the more serious are those commercial panics which bring disasters on multitudes and injuriously affect all."—*Knowledge.*

THE MYSTIC PROPERTIES OF NUMBERS.

By ÉTIENNE DE LA ROCHE (1538).

One of the earliest French mathematical books is the arithmetic of Étienne de la Roche, in which, the title-page states, are given tables of different accounts, with their canons, calculated by Gilles Huguetan, native of Lyons: "in which may easily be found the accounts all made, as well of purchases as of sales, of all kinds of merchandise. And, principally, of goods which are sold or bought by measure, as by the ell, by the cane, by the toise, by the palm, by the foot, and the like. By weight, as by the pound, by the quintal, by the thousand-weight, by the load, by the half-pound and the ounce, by the piece, by the number, by the dozen, by the gross, by the hundred, and by the thousand. With two tables of use to booksellers, in selling and buying paper, together with a table of expense, showing, at so much a day, how much one spends by the year and the month, and at so much a month how much it comes to by the year and the day, and at so much a year how much one spends in a month and how much it comes to for each day.

"Further, tables of the fineness of gold and silver, showing, according as the coin contains of alloy or fine metal, how much it is worth in the weight of fine gold or of fine silver.

"Sold at Lyons, at the sign of the Sphere, by Gilles and Jaques Huguetan Brothers, 1538."

We give the first chapter of this curious work, which treats of the first twelve numbers, their properties and perfections. Our modern works, while they are less unsophisticated, are certainly far less amusing in expounding the beginnings of arithmetic:

"Number, according to Euclid, at the beginning of the seventh book: *Est multitudo ex unitatibus composita* (is multitude composed of units). And, again, in the third part of his first book he says: *Seriem numero et in infinitum posse procedere ut quocumque numero dato dari potest major unitatem addendo.* (A series in number may go on to infinity, so that any given number may be made larger by adding unity.) And in this way number is an aggregation or collection of one or many units. And to proceed *in infinitum* by the addition of one. From which it appears that unity is not number; but, on the contrary, is the root and foundation of numbers. Even as Boëthius says in his arithmetic. Nevertheless, one is higher and more perfect than all the numbers that are. For in it are united potentially the property and perfection of all numbers. And without it nothing can have being. And Euclid, at the beginning of the seventh book, says: *Unitas est qua una quacumque res una dicitur* (Unity is that by which any one thing is called one). And the logicians say that one is one of the six transcendent principles. For it comprehends all things that have being. Then, again, it has all the property of number. For it is perfect, like six, it is lineal, square, cube, solid, square root, cube root, root of root. And because it is of so great dignity and excellence, the Creator has chosen it for his essence; for he is one only God, creator of all the world. A good law, to wit: the Christian law, divided into ten commandments. And a good faith: to wit, the Catholic faith, divided into twelve articles. And so many other dignities and perfections.

"Two is a number of so great pre-eminence and utility that God has kept it in mind in many of his works. For first, he created light and darkness. Then he created two great lights, to wit, the sun and the moon. The sun, to light the day; and the moon, to light the night. Then he created all beasts in two sexes, to wit, masculine and feminine; and made for them several double members, to wit, two eyes, two ears, two nostrils, two arms, two hands, two legs, two feet and many others of utility to the human body. And then, as many passions as the human body suffers, such as joy and sadness, hope and fear, hunger and thirst, heat and cold, drinking and eating, sleeping and waking, health and sickness, living and dying, and all relative qualities are also constituted in duplicity, as creator and creature, parent and son, creating and created, producing and produced, abstract and concrete, etc. And also all opposites, as kindness and malice, virtue and vice, knowledge and ignorance, wisdom and foolishness, truth and falsehood, etc. And we think that after unity more things are found constituted by two than by any superior number.

"Three is the most worthy and most perfect, after one, that is among the numbers. Thus, as says almost every one's maxim, *Omne trinum perfectum* (Every trine is perfect). And the perfection does not proceed by the composition of it, as it does of six. But by the great and high mysteries that are found in this number. And first, it has pleased God, the Creator, to be trine in persons. To wit, Father, Son, and Holy Ghost. It has pleased him to create three hierarchies; and in each hierarchy three orders of angels. There are three things in Jesus Christ, to wit: deity, the soul, and humanity. The priest makes three parts of the precious body of Jesus Christ in the mass. Three holy orders sing the mass, to wit: the priest, the deacon, and the sub-deacon. Three times are sung the *Sanctus, Sanctus, Sanctus;* and the *Agnus Dei qui tollis peccata* in the mass. By three nails was fastened the Blessed Redeemer Jesus Christ on the cross. There are three degrees of penitence, to wit: contrition, confession, and satisfaction. There are three parts of satisfaction, to wit: fasting, alms, and prayer. There are three divine virtues, to wit: faith, hope, and charity. There are three enemies of the soul, to wit: the world, the flesh, and the devil. Man sins in three ways, to wit: with heart, with word, and with deed. Man may offend three things, to wit: God, himself, and his neighbor. God has disposed all things by number, by weight, and by measure. *Tria erant in archa; s. c. g. Virga; manna et lex Mosayca* (there were three things in the ark: the rod, the manna, and the Mosaic law). Three places are deputed for man after his death, to wit: paradise, purgatory, and hell. Three vows do the minor friars vow when they make profession, to wit: poverty, obedience, and chastity. There are three natural principles, to wit: form, matter, and privation; or, *potentia* (power); *objectum* (object); *et actus* (and act). There are three souls, to wit: vegetative, sensitive, and rational. There are three powers in the rational soul, to wit: will, memory, and understanding. Bodies have three dimensions, to wit: length, breadth, and thickness. The world is divided into three parts, to wit: into Asia, Europe, and Africa. And thus appears the excellence and magnificence of this worthy number three.

"Four is the first square number, and is of great esteem and necessity. And first, God, the Creator, has created four elements, to wit: fire, air, water, and earth. Whence proceed four qualities, to wit: warmth, frigidity, dryness, and moisture. From which arise four humors, to wit: blood, bile, phlegm, and melancholy; by which are caused four complexions, to wit: sanguine, choleric, phlegmatic, and melancholic. There are four seasons in the year, to wit: spring, summer, autumn, and winter. And four quarters in the sky and the world, to wit: eastern, western, northern, and southern. And to each quarter one principal wind, to wit: the morning or east-wind, the traverse or west-wind, the north-wind or transmontane, and the sea or south-wind. And, according to the philosophers, there are four causes in all things, to wit: the efficient, formal, material, and final causes. There are four cardinal virtues, to wit: prudence, temperance, strength, and justice. The glorified body in paradise has four endowments, to wit: brightness, subtilty, agility, and impassibility. There are four evangelists to certify the faith of Jesus Christ. And four principal doctors of the Church to corroborate the faith, to wit: St. Augustine, Gregory, Hieronymus, and St. Ambrose.

"Five is a number of great convenience and utility; for, first, the Creator created five simple bodies, to wit: the sky, fire, air, water, and earth. And never have more of regular bodies that have equal bases been found. Then, for our use, the Creator has given us five natural senses, to wit: sight, hearing, taste, touch, and smell. And five fingers on the hand, and five toes on the foot. And to redeem us has suffered five wounds on the cross, and in all the surface of the earth there are five zones, according to Sacrobosco in his sphere.

"Six is the first and most worthy of the perfect numbers. Because in its composition three aliquot parts put together make their whole: as 3, 2, and 1, which are its $\frac{1}{2}$, its $\frac{1}{3}$, and its $\frac{1}{6}$. Which put together amount to 6, which is their whole. There is another perfection, because it is a circular number. For, in making a circle with a compass, the circumference of the circle contains just six times the span of the compass; as when one should put one of the feet of the said compass on the circumference of the said circle, and should turn the said compass to six times on the said circumference. At the sixth time the said foot of the compass would return to its first point. And because it returns always in itself. *Et semperidem ipse est* (and it is always the same). There is also another perfection, because there are six transcendent principles, to wit: one, good, true, thing, something, and being. And for these great perfections and dignities, the Creator regards it in his works, for he created everything in six days. Therefore ought it to be named the very perfect among the perfect numbers. So has St. Augustine said in the thirtieth chapter of the second book '*De Civitate Dei.*'

"Seven is a number of great prerogative and singularity, as St. Augustine says in the thirty-first chapter of the aforesaid book. Because of its composition which is triple, for first it is composed of 1 and of 6, which are of so great perfection as is said above. Or of 3 and 4, which are of so great dignity and estimation. Or of 2 and 5, which are of so great utility and commodity. And because in its composition it contains so many numbers worthy, perfect, and of great excellence. God, the Creator, regards it in his most admirable works. For he has created seven planets, seven metals, seven colors, and seven tastes. And when he had created everything in six days, he rested on the seventh, which is a thing of great mystery. There are, therefore, seven days in the week. There are seven principal virtues, to wit: three divine, and four cardinal. There are seven other virtues against the seven mortal sins. There are seven works of bodily mercy and seven works of spiritual mercy. There are seven sacraments. There are seven orders in the holy church. There are seven ages of man. There are seven windows through which the ordinary senses are exercised: the two eyes, the two ears, the two nostrils, and the mouth. There are seven days between the setting in of a disease and the critical day. There are seven climates in the habitable earth.

"Eight is the first cube number, and there are also eight beatitudes.

"Nine is the second square number, and there are also nine orders of angels and the *kyrie eleison* is sung nine times in the mass.

"Ten, according to some, is a perfect number, not in its composition like six, but because it contains inclosed in itself all the simple numbers and all the properties, as of even and odd, perfect and imperfect, and it is the beginning of all numbers composed of tens, and also for the foundation of our law. God gave to Moses the ten commandments of the law, and ordered men to give to God the tithe, which is one tenth of his gain or his labor.

"Eleven is the first compound odd number.

"Twelve is a number of great pre-eminence and utility. And, although it is an excessively imperfect number, it is nevertheless of great utility. For it can, first, be divided into more parts than any number below it. For it can be evenly divided by 6, which is its $\frac{1}{2}$; by 4, which is its $\frac{1}{3}$; by 3, which is its $\frac{1}{4}$; and by 2, which is its $\frac{1}{6}$. And because the blessed Redeemer Jesus Christ wished to observe the said number in choosing twelve apostles to found and form the Holy Catholic Faith. Who for the foundation of the same composed the twelve articles of the faith. And in imitation of them the lords of the cathedral churches constitute twelve perpetuals to listen continually to the service of God the Creator; twelve choralists to sing the hymns of God and the saints. Likewise, on account of the convenience of this number, the good governors of cities commonly choose twelve counselors to attend to the regulation of the public good. So the astrological philosophers of the ancient times, experimenting and considering the celestial natures and influences, divided the whole sky into twelve equal parts which were called the twelve signs. And they attributed to each a peculiar influence by subtile commixtion, and established twelve months in the year for greater convenience. And this is enough of the property of the numbers in particular.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF PROFESSOR FELIPE POEY.

By Professor DAVID S. JORDAN.

"AH, but you must see Don Felipe—he knows all about fishes!" is the first advice which the naturalist receives when he begins to make collections of fishes in the markets of Havana. The writer once had occasion to make such a collection, and he found soon that, among fishermen and fish-mongers, the phrase "amigo de Don Felipe" was ever a passport to honest dealing and to a real desire to aid him in his work. For every fisherman in Havana knows "Don Felipe," and looks upon him as a personal friend. Each one regards the fame which Don Felipe's studies of the fishes is vaguely understood to have brought him in that little-known world outside of Havana as in some sort reflected on himself. The writer was told, by a dealer in the Pescadería Grande, that for twenty years Don Felipe Poey was there in the markets every day, when at noon the fishes came in from the boats, and that he knew more about the fishes of Cuba than even the fishermen themselves. And, now that Don Felipe no longer visits the markets, he is not forgotten there, and many a rare specimen still finds its way from the Pescadería to Don Felipe's study in the Calle San Nicolas.

Felipe Poey y Aloy was born in Havana, May 26, 1799. His father was French, his mother Spanish, but Poey early renounced his French citizenship for that of Cuba. His education was received in Havana, and after studying law he became, in 1823, an advocate in that city. But his tastes lay in the direction of natural history, and for this he gradually abandoned his practice as a lawyer. Very early he had made discoveries of mollusks, insects, and especially of fishes, which were new to science. In 1826 he sailed for Paris, taking with him eighty-five drawings of Cuban fishes and a collection of thirty-five species, preserved in a barrel of brandy. These drawings and specimens he placed at the service of Cuvier and Valenciennes, who were then beginning the publication of their work on the "Natural History of the Fishes." The notes and drawings of Poey proved of much service to the great ichthyologists. A few new species were based on them, and Poey had the satisfaction of finding his own name and observations cited by Cuvier and Valenciennes even more frequently than those of his famous predecessor, Don Antonio Parra,* who had published, in 1787, the first account of the "Fishes of Cuba." A set of duplicates of these notes and drawings is still retained by Professor Poey. While in Paris, Poey was one of the original members who founded the Entomological Society of France.

On returning to Havana in 1833, Poey gave himself still more fully to the study of natural history, and greater practice gave to his drawings and notes more exactness and value. With the appearance of the successive volumes of the "Histoire Naturelle des Poissons," he attempted to identify the fishes of his market, as well as to study their osteology and general anatomy. Animals other than fishes he also tried to study, but in most groups he found the literature in so scattered and unsatisfactory a condition that he rarely ventured to publish the results of his observations. Among the fishes, however, thanks to the general work of Cuvier and Valenciennes, and later to that of Dr. Günther, he felt himself on comparatively firm ground, and ventured to name as new those which he could not identify. Among the land-

* "Y tuve el honor de ser citado por él (Cuvier) y por su colaborador Valenciennes, más frecuentemente que D. Antonio Parra."—Poey.

snails, too, Poey and his associate, Dr. Gundlach, were able to act with certainty, as all the species then known were included in the "Monographium Heliceorum Viventium" of Dr. Ludwig Pfeiffer.

In the year 1842 Poey was appointed to the professorship of Comparative Anatomy and Zoölogy in the Royal University of Havana, which chair he still holds, after forty-two years.

The University of Havana occupies an ancient monastery building in the heart of the city. Like most similar edifices in Cuba and Spain, it is a low building around a hollow paved court, and its whitewashed, time-stained walls have an air of great antiquity. The university has now some twelve hundred students, the great majority of whom are in those departments which lead toward wealth, or social or political preferment, as law, medicine, and pharmacy. Comparatively few pursue literary or philosophical studies, and still fewer are interested in the biological sciences. In the department of botany there are now but two students, and the number in zoölogy is probably not much greater.

Although Professor Poey is evidently held in very high respect in the university, in which he has long been dean of the faculty of science, I can not imagine that he ever received much help or sympathy in his scientific work from that quarter, or indeed from any other in Cuba. His friends and countrymen are doubtless glad to be of assistance to so amiable a gentleman as the Señor Don Felipe, but for the claims of science the people of Cuba, as a class, care very little.

The university library contains but little which could be of help in Professor Poey's zoölogical studies. He has therefore been compelled to gather a private library of ichthyology. This library has with time become very rich and valuable, many of his co-workers in the study of fishes, notably Dr. Bleeher, having presented him with complete series of their published works.

The museum of the university occupies two little rooms, the one devoted chiefly to Cuban minerals, the other containing mostly mammals, birds, and fishes mounted by Poey himself in the earlier days of his professorship. The number of these is not great, nor have many additions been made during the last twenty years. Of late the types of the new species described by Professor Poey have been, after being fully studied by him and represented in life-size drawings, mostly sent to other museums, notably to the United States National Museum, to the Museum of Comparative Zoölogy and to the Museum of Madrid. Duplicates have been rarely retained in Havana, the cost of keeping up a permanent collection being too great. As a result of this, Professor Poey's work has sometimes suffered from lack of means of comparing specimens taken at different times. There is no zoölogical laboratory in Cuba except the private study of Professor Poey, and here, for want of room and for other reasons, drawings have, to a great extent, taken the place of specimens.

The publication of the observations of Professor Poey on the animals of Cuba was begun in 1851, in a series of papers entitled "Memorias sobre la Historia Natural de la Isla de Cuba." These papers were issued at intervals from 1851 to 1860, and together form two octavo volumes of about 450 pages each. The first volume contains chiefly descriptions of mollusks and insects. The second volume is devoted mainly to the fishes.

As is natural in the exploration of a new field, these volumes are largely occupied with the description of new species. They give some evidence of the disadvantages arising from solitary work, without the aid of the association and criticism of others, and without the broader knowledge of the relations of groups which comes from the study of more than one fauna. On the other hand, Professor Poey enjoyed the great advantage of having an almost exhaustless supply of material, for there are few ports where fishes are brought in in such quantities, or in such profusion of variety, as in the markets of Havana.

The "Memorias" were at once recognized as the most important work on the fishes of Cuba, and, as was said long ago by Professor Cope, this work is a *sine qua non* in the study of the ichthyology of tropical America.

The nomenclature and grouping of the species in the "Conspectus Piscium Cubensium," contained in the "Memorias," was in 1862 the subject of a critical paper by Dr. Theodore Gill.* This article, and subsequent ones by the same author, exerted much influence on Poey's work. He was always ready to profit by the suggestions and advice of other writers, especially of those more favorably situated than he in regard to libraries and museums, and from Professor Gill's papers he drew clearer views of the relations of forms, and of the connection of the Cuban fauna with that of other regions. On the other hand, he was led to adopt, against his own judgment in many instances, that minute subdivision of genera which has been a fashion in American ichthyology, and which has been in some quarters a reproach to American science.

In 1868 the results of the revision of his classification were embodied in a second catalogue of the Cuban fishes, entitled "Synopsis Piscium Cubensium." This forms the concluding chapter of a series of papers, entitled "Repertorio Físico-natural de la Isla de Cuba," which embody the results of a general scientific survey of the island. Of this survey Professor Poey was director. In 1875 the entire list of species was again revised, and the third and best catalogue of Cuban fishes was published under the title of "Enumeratio Piscium Cubensium." Besides these larger works, many shorter papers by Poey occur in the "Proceedings of the Academy of Natural Sciences" of Philadelphia, the "Annals of the New York Lyceum," and the "Anales de la Sociedad de Historia Natural de Madrid." He is also the author

* "Remarks on the Genera and other Groups of Cuban Fishes," "Proceedings of the Academy of Natural Sciences," Philadelphia, 1862, pp. 235, *et seq.*

of a "Geography of Cuba," and of a "Treatise on Mineralogy," used in the Havana schools. A number of poems from his pen have likewise been published, but these I have not seen.

The great work of Poey's life is the still unpublished "Ictiología Cubana." This is to contain a detailed account of each of the fishes of Cuba. It is to be composed, according to a statement of Poey, published in a Havana paper, "of a thick volume of text, Spanish folio, and of an atlas of ten volumes larger folio (eighteen by thirteen inches). The plates are made with a light indication of the colors, which are described in the text. All are original, drawn from nature by the author. . . . The text contains the scientific name of each species, the common name, the complete synonymy, a description of the colors, distinctive peculiarities, relations of the varieties, comparisons, critical observations, and the history of the fish. It contains, moreover, the characters of classes, sub-classes, orders, families, genera, and species. The total number of plates in the Atlas is 1,040. These show 758 species of Cuban fishes, represented by 1,300 individuals in all stages of growth. All except the sharks are drawn of life-size.

"These 758 species, together with 24 mentioned at the end of the work, make up 782 species of Cuban fishes. Of these, 105 are doubtful, and therefore are left without specific names. I hold them in suspense till I can receive further data from the study of other specimens. There are, therefore, 677 species well determined, of which more than half have been first made known by me. Not more than a dozen species in the list have not been examined by me. These are inserted on the authority of writers who claim to have received their specimens from Cuba, and who appear to be worthy of confidence.

"The preparation of the text has cost me an immense amount of time and labor, by the preparatory studies which it has required. In the determination of the species it is rarely that a single one has not occupied me for an entire week. I have wished to make known the certain as certain, and the doubtful as doubtful, so that I shall declare nothing to be new unless it is so in reality."

The manuscripts of this great work are now in duplicate. One copy is retained by Professor Poey; the other has been purchased by the Spanish Government for $5,000. It is expected and earnestly hoped by Professor Poey and his friends that the Government will soon order its publication, but, unfortunately, there seems to be no certainty of this.

The manuscripts and drawings of the "Ictiología Cubana" were placed on exhibition by the Spanish Government in the Exposition of Amsterdam in 1883. In testimonial of their worth, Professor Poey has received from King William III the decoration of the order of the "Lion Néerlandais." Before this, as the most distinguished of Spanish naturalists, he had received from the King of Spain the title of "Encomendador de la Orden de Isabella la Católica."

Among the manuscripts of Professor Poey, with the title of "Corona Poeyana," is a list which he is sometimes fond of contemplating, of the species of animals which were first made known by him. This list is a long one, longer perhaps than that of any other zoölogist of our times who has confined his studies to a single fauna.

It is a fashion in some quarters to decry the work of the describer of new fauna. All honest study has its equal place, and, till the pioneer work of exact determination of species is performed, there is little opportunity for the embryologist or the anatomist. It is of little use to record the structure or the development of an animal while the animal itself remains unknown.

There is no characteristic of Professor Poey's work more striking than his entire lack of prejudice, or, in other words, his teachableness. A certain zoölogist was once described to me by Dr. Kirtland as "a little man who couldn't be told anything." His character was in this regard just the reverse of that of Professor Poey. Among all the eminent zoölogists of our time, I know of none so ready to learn, whatever the source from which information may come. He has no theories which he is not ready to set aside when a better suggestion appears. Unlike some other systematic writers, he exhibits no preference for his own names or subdivisions, but is as ready, if the evidence seems to require it, to smother one of his own species or genera as those of another.

His work shows no sign of falling off in quality. The clearness of his judgment and the accuracy of his memory seem unimpaired. It is difficult in conversing with him to realize that he was born in the last century, and that in his earlier studies he was a cotemporary of Cuvier and Valenciennes, and of Geoffroy Saint-Hilaire. Most men are older at fifty than Poey at eighty-five.

Poey was married in 1825 to María de Jésus Aguirre. He has had six children. Two of his daughters still reside with him at Havana, and their skillful hands have been of great service to him in the preparation of his drawings and manuscripts.

Poey is rather above the medium height, well-formed, and in his younger days he was remarkably active and vigorous. Even yet, time rests lightly on his shoulders. His complexion is fair, and his hair and eyes are not dark. He has little of the appearance of a Spaniard or indeed of any especial nationality. As he himself has said, "Comme naturaliste, je ne suis pas espagnol : je suis cosmopolite." He is of a happy temperament and has a peculiarly genial and cheery smile. Simple, direct, unaffected, but possessed of a quiet dignity, he is certainly one of the most delightful men I have ever met. Of all men I have known, he has best learned the art of growing old.

EDITOR'S TABLE.

SCIENCE AND THE TEMPERANCE REFORM.

THE Legislature of the State of New York has passed a law providing for the instruction of "all pupils in all schools supported by public money, or under State control, in physiology and hygiene, with special reference to the effects of alcoholic drinks, stimulants, and narcotics upon the human system." Other States have passed similar enactments, so that there seems to be something like a general movement appealing to this new form of influence for the promotion of the cardinal objects of the temperance reform. That movement has relations with various sciences, not only with physiology, but also with sociology, and perhaps some reference to its history will help us to judge of the promise of the new measure.

The bad effects that flow from the excessive use of spirituous liquors, and the evils of drunkenness, have been recognized and deplored in all times. While every literature has its poetry in praise of the cheering influence of wine, so it has its proverbs showing the evil consequences of devotion to the intoxicating cup. But the first organized movement to check the excessive use of intoxicating liquors belongs not only to modern but to very recent times. The temperance reform was inaugurated but a little over half a century ago. Numerous societies were formed, with wide affiliations, to act upon public opinion in the most efficient and persistent manner. There rapidly grew up a copious and varied temperance literature, consisting of explanations of the injurious action of alcoholic liquors, of vivid delineations of the results of the inebriating habit, of statistics of the criminality and pauperism that flow from it, of its enormous cost to the community at large, of impassioned appeals in sermons and lectures, and of poetry and fiction all combined, for the promotion of the philanthropic objects of the temperance associations.

The characteristic of the temperance movement at this early stage was the directness of its personal appeals to influence voluntary action. Individuals were plied with facts and arguments, and on grounds of self-respect and social obligation to abstain from the habit which had its root in the selfish appetites, and bore the fruits of suffering to the victim, calamity to the family, and grave detriment to society. To give the utmost support to voluntary action, the pledge was introduced, which offered the advantage of an explicit written committal, and a public avowal of the purpose of the individual to abstain from spirituous liquors. In short, the policy was to influence persons, by every consideration that could be urged, to the practice of restraint and temperance in the use of alcoholic beverages. The movement was pushed with fervor and zeal, and every expedient resorted to, to gain the result. The pledge in favor of the temperate use of spirituous liquors was changed to a pledge against all use of them, on the ground that moderation, by the laws of human appetite, rapidly passes to excess.

Among the means of influence, Science was, of course, called upon to give its evidence. Prize essays by distinguished medical men on the physiological effects of alcohol were multiplied, and tracts stating the results were sown like autumn leaves through the community. One of the most eminent of the reformers, Mr. E. C. Delavan, after laboring long, and devoting great wealth to the promotion of the reform without the full results which he had anticipated, acknowledged his discouragement to a sagacious friend, who suggested to him that there was a sure way in which the cause might be made to succeed. "It has been shown," said he, "that the use of alcohol is very injurious to the human stomach. Men care for their stomachs more than for anything else. Prove to them that alcoholic liquors impair and destroy the digestive organs, and your case is won and that work done." Mr. Delavan, accordingly, had prepared a series of colossal lithograph plates, showing the progressive influence of alcohol upon the coats of the stomach, from the first congestion that follows moderate indulgence in the stimulant, onward through the stages of inflammation and disorganization to the final ulcerated condition shown by the *post-mortem* of habitual drunkards. The enterprise was pushed with great vigor. Hundreds of thousands of dollars were spent in the manufacture of these stomach-charts, and they were hung up conspicuously in the halls of court-houses, on the walls of public institutions, and in all places where they could be observed by everybody. That these illustrations did good service there can be no doubt, although able medical men denied their strict accuracy. One effect was to concentrate so much attention upon the stomach that all other parts of the human system were neglected, and this made necessary new scientific expositions, showing that the peculiar and most injurious effect of ingested alcohol is upon the nervous system and the brain.

But, while great good was undoubtedly accomplished by the means adopted, and, indeed, all the good that could be expected from them, the results were still unsatisfactory—that is, the evil of intemperance was not swept from the country as the sanguine reformers had anticipated. The movement was driven as a crusade having a definite end. Attention was so concentrated upon the evils of intemperance that they came to be considered as almost the only evils with which mankind are afflicted. Fervor of feeling grew into heated and passionate partisanship, with impatience of tardy results. There was but little recognition of anything like natural laws in the case, and no admission of the great truth that radical changes in the conduct of human nature must proceed slowly and are limited by many conditions. There grew up a conviction that the temperance movement as thus prosecuted had proved a failure. Men had been instructed, persuaded, and denounced, until it was felt that these agencies had accomplished everything of which they were capable, and it was resolved to push on to more stringent measures. If men could not be induced to abstain voluntarily from the use of intoxicants, then they must be compelled to abstain. Government must be appealed to, to force the results which moral influence had failed to secure. If men would not stop drinking, they must be deprived of the means of drinking, and so it was determined to strike at the trade in alcoholic liquors, and to outlaw it by prohibitory legislation.

The temperance question was thus launched into politics, a change of great import, as it was the virtual abandonment of the policy hitherto pursued. Moral influences were, of course, not openly repudiated, but it remains true that they no longer characterized the temperance movement. The faith in them had departed, and its place was taken by the new faith in the efficacy of political action. We called attention last month to the overshadowing influence of the great superstition that political agencies are omnipotent for the accomplishment of social ends.

In the face of notorious facts, and in the teeth of all experience, we cling to the notion that government can do everything; so that now it is widely believed that a reformation of social habits, involving the strongest appetites, which it has been impossible to bring about by the most vigorous, prolonged, and comprehensive moral movement of modern times, can still be brought about through the passage of enactments by political majorities.

How far this change went may be further illustrated. In the first stage of the temperance movement the wrong to be righted was on the part of the individual who indulged in drinking-habits. The practice was denounced because held to be intrinsically immoral, self-destructive, and vicious in all its influences. The turpitude and wickedness of the case consisted in the act of indulgence. But, with the change of tactics on the part of the reformers, the point of assault was shifted: the pressure was virtually taken off the party that committed the wrong act, and applied to the commercial transaction that preceded it. The liquor-trade was denounced as the real root of the evil of intemperance, and the men who sold alcoholic spirits were held to be the culpable offenders and the criminals who deserved to be dealt with by punishment like other criminals. Yet the sale of liquors, like the sale of anything else, is a compound transaction—a seller implies a buyer—and they are both voluntary parties to the proceeding. If that proceeding is wrong, both are to be condemned—certainly the one who makes the demand as much as he who supplies it; and, if the partnership transaction is criminal, it is difficult to see why both should not be punished alike. But, in the new aspect of the case, he who drinks is virtually relieved from condemnation, while those who sell him the beverage become the objects of concentrated reprobation, to be punished with the full severity of the law. This fundamental change in the policy of the temperance movement, involving as it does the virtual abandonment of those agencies which are most proper to influence conduct, and which were clearly vindicated in their beneficent working, can hardly be regarded as a step forward in the legitimate development of the temperance movement.

It is in the light of such experiences that we are to consider the measure now brought forward for the further promotion of abstinence from intoxicating liquors.

This measure is a partial reversion to the older method, and may be characterized as politico-educational, with special relation to the scientific aspect of the subject. It is proposed to give instruction in relation to the physiological effects of alcohol, and thus, as has been said, "to play the school-house against the saloon." It may be well to do this, but it will be wise not to expect too much from it. It is a very crude measure, and has been born of temperance zeal rather than any intelligent appreciation of the subject.

In the first place, the action of alcohol and the narcotics upon the human system opens one of the obscurest, and we may add, the most unsettled, of all questions. But little, in fact, is known of the *modus operandi* of these agents upon the nervous system, where they take such special and disastrous effect. School-teachers can not explain it—doctors can not explain it; no two will agree about it. The theories of the behavior of alcohol in the human system have undergone change after change within a generation, and we are probably but little nearer the final solution of the problem than when the first experiments were made upon cats and dogs to solve it.

In the next place, the amount of physiology that is or that can be taught in common schools, and by all the teachers under State control, is grossly insufficient to make intelligible what is known of the physiological effects of alcohol. The crude smattering of physiology got in such schools under ordinary teaching is absolutely worthless as a preparation for understanding the subtile influence of narcotic agents upon the nervous constituents and the nervous mechanism. What is taught will not be science, which must explain things, only sham science; will not be real knowledge or anything understood, but only the words of a lesson.

No doubt something will be gained by calling attention to the subject, but the question is, if the method proposed is the best that could be adopted. We doubt if the appeal to science through such teachers as we have, and such books as most of those that are now appearing, to meet the new emergency, is the best way of securing the end desired. What is wanted is to make the deepest and most indelible impression upon the minds of youth in regard to the bad effects of indulgence in alcoholic beverages. But the attempt to expound the physiology of the subject is not the best way to accomplish this object. The evils of intemperance are evils which openly appear in conduct. The incontestable facts of the injurious influence of drinking are direct, palpable, conspicuous, observed by everybody, and open to no question. Science can not make them more clear, or add vividness to the painful facts which are seen by all. Good may come, as we have said, but it is a question if more good would not come from the dogmatic statement of facts, that are free from doubt and obscurity, and that are based upon unquestionable and established experience. The subject in its scientific aspects is beyond the grasp of pupils in common schools, but maxims and rules can be stamped upon their minds in a way that will exert a salutary and permanent influence. And if it is desired to teach the young to *think* upon the subject, then let the victims of alcoholic indulgence be taken as *object-lessons*, in which what the pupil sees himself becomes the basis of the opinions he forms. Every community is full of examples of the effects of drinking, and these effects are seen in all possible degrees. Let the scholars be directed to observe for themselves, and see how much truth they can find out on all sides of the subject; the exercise will at any rate be an excellent means of mental improvement and practical education.

LITERARY NOTICES.

Geological Excursions, or the Rudiments of Geology for Young Learners. By Alexander Winchell, LL. D. Chicago: S. C. Griggs & Co. Pp. 234. Price, $1.50.

In his experience as a teacher of geology, and interested in extending a knowledge of this interesting and important subject in the common schools and among the people, the author of this work found himself confronted with this formidable difficulty, that "in most of our colleges, no knowledge whatever of the subject is required for entrance, and there is no course where geology is a prerequisite; and since geology is not required for entrance into college, it has ceased to be taught in the schools—as if geology had no uses, if not demanded as a preparation for college." As our higher educational system, therefore, virtually works against the recognition of this science, the difficulty must be met by preparing the necessary rudimentary books for introduction into the schools, on the ground of the importance of this kind of knowledge, and with no reference to the influence of the colleges. Dr. Winchell says: "As geology is not taught in the schools, and as nineteen twentieths of our teachers have not studied it in college, there is almost no preparation among teachers of primary or secondary grades to induct a pupil into an elementary knowledge of the subject. The only hope of early reform seems to lie in furnishing teachers with a text-book so framed as to be capable of successful use by a teacher without previous acquaintance with the subject. Certainly, no such text-books exist; for though there are several which might be employed by teachers thoroughly disciplined by previous study, the large majority of our teachers are not so disciplined. These text-books, moreover, are too much conformed to the dogmatic or didactic method—telling about things which are far away, or, if near at hand, are not identifiable by the aid of the book. Due discrimination is not observed between those conceptions of the subject which are abstract, and beyond the reach of the young pupil or older novices, and those which can be attained through accessible concrete illustrations."

The method of these "Excursions" is practical, and implies the observation and study of geological phenomena as they lie all about us among the most obtrusive and noticeable of the objects which we daily encounter. The author, moreover, informs us that a large part of the "Excursions" has been used while yet in manuscript, in actual trials by actual teachers. This is unquestionably the true method in scientific education, because it makes the mental acquisitions real, and the adoption and extension of this plan of study is unquestionably the great desideratum of the time.

Brain-Exhaustion, with some Preliminary Considerations on Cerebral Dynamics. By J. Leonard Corning, M. D. New York: D. Appleton & Co. Pp. 235.

Interesting and valuable as are the investigations that have been made upon questions of muscular dynamics, Dr. Corning believes that the economical questions involved in normal and morbid intellection constitute a field of physiological research that transcends all others in importance. With the growing demands made in the present conditions of society upon the thinking apparatus come factors to exert a prejudicial influence upon the cerebral mechanism; and these have never been more numerous than now, as is proved by the alarming increase of brain disorders during the last few years. Dr. Corning has endeavored to consider a group of symptoms, associated with these disorders, from as scientific a point of view as possible. The opinions he expresses have been formed from direct clinical observation, and from inferences derived from physiology and experimental pathology. In a chapter of "Preliminary Considerations" he discusses the relation of the law of the convertibility of forces to the dynamics of the healthy and the morbid brain; the emotions of the healthy and morbid mind, and memory in its healthy and morbid relations. In the two following chapters are considered the clinics and pathology, and the causation of brain-exhaustion; account being taken in the latter chapter of predisposing and exciting causes, false educational conceptions and methods, the effects of tobacco and alcoholic excesses, and "mental hygienics." The last chapter is devoted to the principles of treatment. Rest is prescribed as the most wholesome and efficient remedy. Drugs are objected to, but coca is prescribed as an excellent remedy against worry, and one which, besides exercising an invigorating effect upon the cerebral centers, "imparts an indescribable sensation of satisfaction." A special treatment by electrization of the sympathetic nerve, with simultaneous bilateral compression of the carotids, is described.

Methods of Historical Study. By Herbert B. Adams, Ph. D. Baltimore: N. Murray. Pp. 137. Price, 50 cents.

This treatise constitutes the opening double number of the second series of the "Johns Hopkins University Studies" in historical and political science, and includes papers describing improved and special methods of historical study that have been introduced at the university, and at other institutions in the United States and Europe. The main principle of the training at Johns Hopkins is to encourage independent thought and research. Little attention is given to text-books and mere phraseology, but all stress is laid upon clear and original statements of fact and opinion, whether the student's own or a consulted author's. At Smith College the study is pursued by four classes in regular gradation, with liberal use of collateral literary works and historical romances as aids to the lectures and formal treatises. In another paper are given expositions of four new methods of historical study, viz., the topical, comparative, co-operative, and seminary or laboratory methods. In the first method the study is begun with and enlarged from some special topic, preferably from one which is nearest and most familiar. In the comparative method, like phases of history are studied connectedly. In the co-operative method, each student makes a thorough study of a single branch of the subject, and the work of all is so co-ordinated in the class that each member may, to some extent, reap the benefit of the labors of his companions. The seminary method is adapted from the old scholastic methods of the ecclesiastical and philosophical seminaries, and has been applied in numerous German and some American institutions.

The Bible analyzed in Twenty Lectures. By John R. Kelso, A. M. New York: "Truth-Seeker" office. Pp. 833. Price, $3.

We believe that the Bible should be subject to criticism and investigation, in all its aspects, like any other book; and that the criticism should be searching and fearless. Still, there are proprieties to be observed, even by a critic who does not believe the book the product of divine inspiration. It is a very ancient book, embodying unique historical records and traditions of the earliest times of civilization, the genuineness of which is newly illustrated by every new excavation in the ruined cities of the East; prophetic books and poems which, regarded in the literary aspect alone, are worthy to be ranked with the world's masterpieces; and religious declarations and moral precepts which have been built into the foundations of modern manners. These things should entitle it to respectful treatment, even at the hands of an enemy. Mr. Kelso has not given it such treatment, but has made it the object of persistent ribald, indecent, blasphemous assaults, the very violence of which obscures whatever of force his argument might have had he presented it in a becoming style.

The Book of the Beginnings. By R. Heber Newton. New York: G. P. Putnam's Sons. Pp. 310.

In this little book Mr. Newton gives a study of Genesis, with an introduction to the Pentateuch, conducted according to the canons of free, independent investigation. The study is based upon the lectures which the author, a well-known Episcopal clergyman, had begun to deliver to his Bible-class, but which he discontinued at the request of his bishop. The singular position in which he was put by this event made it seem due, he says, "alike to my people and myself, that the public should be enabled to judge of the real nature of the lectures which had called forth such a very unusual if not unprecedented episcopal interruption of a presbyter in the course of his parochial ministrations." Mr. Newton accepts to the full the results of what is called the "new criticism" with regard to the mode of composition, the time, and the authorship of the five Mosaic books; and while he presents these clearly and in all their force, he does it in the spirit and with the manner of one who accepts, as he avows that he does, the religious teachings of the Bible as authoritative.

The Outskirts of Physical Science. Essays, Philosophical and Religious. By T. Nelson Dale. Boston: Lee & Shepard. Pp. 187. Price, $1.25.

The studies contained in this book seem to be products of a mind much exercised about the relations of religion and modern science. Its author has read widely, and is evidently in much sympathy with the study of natural science, for which he declares he had an early fondness, while he possesses strong religious convictions, and strives with sincerity to bring the two orders of thought into unity and harmony. The second part, on "Scientific Studies: their Place and Use in Education," presents a very fair *résumé* of the educational claims of the sciences, but the author is still in agreement with the classicists, holding that there is nothing like "the humanities" for the cultivation of the mind.

Home and School Training. By Mrs. H. E. G. Arey. Philadelphia: J. B. Lippincott & Co. Pp. 192.

The author of this plea for home instruction has made it under the feeling that the subject has at no time received the attention it demands, but that we are coming to neglect it more and more. We are apt to leave the whole matter of the training of our children to the schools, in utter forgetfulness of the fact that the specially important phase of it—that which forms a symmetrical character—is ostensibly ignored in many of them, and that "the most abiding portion of the child's mental seed-sowing has already taken root and given its tints to the soil before the period for entering the school-room arrives." The oversight of "this first lush growth of the young mind" is the one thing that seems especially given into the hands of the parents, and it is treated by the author as a duty that should be peremptorily observed from the very moment of birth. The subject is handled in all its aspects as by one who is well qualified to do it, and the presentment, both in matter and manner, is admirable.

Lectures on the Science and Art of Education, with other Lectures. By Joseph Payne. New York: E. L. Kellogg & Co. Pp. 2?6. Price, $1.

Dr. Joseph Payne was for many years a distinguished and most successful practical teacher in England, and, retiring from his profession late in life, he continued to devote himself to the subject with great assiduity, and became at this period the first Professor of the Science and Art of Education in the College of Preceptors in London. Dr. Payne was well versed in the history of education, and familiar with the most advanced methods of teaching, and the lectures contained in this volume are the ripe results of wide knowledge and critical experience. The book is full of valuable suggestions and wise practical observations, and will be found very useful to inquiring teachers.

A History of Tuberculosis. By Eric E. Sattler, M. D. Cincinnati: Robert Clarke & Co. Pp. 191. Price, $1.25.

The first five chapters of this book consist of a translation of the first part of a work on "Studies of Tuberculosis," by Dr. Arnold Spina, of Vienna, who is a vigorous opponent of the theories of Koch. These chapters present the results obtained from long series of inoculation, inhalation, and feeding experiments, the first of which date back to 1789, bringing the history of the subject up to March, 1882, when Robert Koch published his investigations. In the next chapter Dr. Sattler presents a review of the steps by which Koch arrived at the conclusion that tuberculosis is caused by a specific micro-organism. Koch's announcements set many investigators at work upon tuberculosis and other diseases supposed to be infectious, and many additional discoveries have been published. There are those also who deny many of the discoveries claimed, and even the existence of the *Bacillus tuberculosis*. After giving some account of the controversy, Dr. Sattler says in conclusion: "Whether Koch has been too sanguine in the one direction, or Spina has gone too far in the other, it is not for us to decide. The great number of scientific men engaged throughout the civilized world in repeating these experiments, and in studying their results, will soon sift out the truth of the matter, and bring the question to a final and authoritative decision."

Biogen: A Speculation on the Origin and Nature of Life. By Professor Elliot Coues. Second edition. Boston: Estes & Lauriat. Pp. 66. Price, 75 cents.

The substance of this disquisition was delivered as a lecture before the Philosophical Society of Washington, and now appears with the trimmings—dedication, mottoes, preface, introduction and appendix—forming altogether a very lively little treatise on biological mysticisms. Professor Coues seems to have got tired of working under the restraints of observation, analysis, and induction at the mere phenomena of life, as is the work-a-day habit of science, and so he determined to break away and have a spree of speculation, and see what might come of it. He makes a rally for the relief and rescue of the old but declining doctrine of the "vital principle," or "vital force," which he denominates "Biogen," and which he insists is a thing, and a very real thing, "possessed of sensible qualities and attributes which may be investigated by proper scientific methods, and by scientific experimentation, quite as readily as any other of the so-called 'imponderables' of Nature. It is as open to examination as luminiferous ether, and its properties if not its substance may be studied as we may study light, heat, or electricity; it is therefore not only a proper object of science, but a proper subject of philosophy." However this may be, it is certain that the doctrine of the "vital principle" was made the most of in times of ignorance before anything was known of the laws of life. The "vital principle" explained everything in the middle ages, and we observe that the publishers of this *brochure*, doubtless aware of the fitness of things, have printed it in mediæval type.

The Land-Laws. ("The English Citizen" Series.) By Frederick Pollock, Barrister-at-Law, M. A., etc. London: Macmillan & Co. Pp. 215. Price, $1.

The land-laws of England, which form the subject of this book, must not be mistaken for the land-laws of the United Kingdom. Scotland has a distinct legal system of her own, with a distinct history; Irish land-law, on the other hand, is nothing but imported English law, with certain modifications, the most important of which have been made too recently, and are too much involved with political questions, to be profitably treated in connection with English institutions. The aim of the author is to make the principles and the leading features of the English law of real property intelligible to a reader who is without legal training, but is willing to take some little pains to understand. "Almost every possible kind of ownership and almost every possible relation of owners and occupiers of land to the state and to one another have at one time or another existed in England, and left a more or less conspicuous mark in the composite structure of the English law of real property." The customary Germanic law, which the Angles and Saxons brought to England, is first taken up; the changes resulting from the Norman conquest are next described; and then follows an account of the legislation through which the modern law has developed. A chapter is devoted to the relation between landlord and tenant, and the book concludes with an examination of some modern reforms and prospects. Several special points are discussed in an appendix.

The Destructive Influence of the Tariff upon Manufactures and Commerce, and the Figures and Facts relating thereto. By J. Schoenhof. New York: G. P. Putnam's Sons.

The contents of this little volume first appeared in communications to the New York "Evening Post," and they are now collected and published by the Putnams for the New York Free-Trade Club. The author of this book seems to believe that the way to develop trade is not to fetter it, and he proves abundantly by copious and varied statistics that the effect of legislative restrictions and congressional control of manufactures and commerce is injurious in proportion to the interference—is destructive rather than properly protective. There is a good deal of excellent sense in this book, and, although it deals chiefly in facts of the statistical kind, it contains many reflections and suggestions that are well worth attention, as, for example, the following:

> The curse of American politics, log-rolling, is also the cause of the absurdities of our "well-balanced tariff." It gave us a system of taxation that grinds every one, does cruel injury to a whole nation of working-people, and good to no one except a few monopolists and tax-gatherers; and it may safely be asserted that the corruption of our politics is largely due to protection, and to the mania for government aid and subsidies engendered thereby. Self-reliance and independence are lost where large profits are more the results of legislative grants extended to industrial enterprises than of unassisted work. The lobbyist seeks, and frequently finds, an open door to executive departments, and it is doubtful whether a civil service can be thoroughly reformed that is constantly exposed to the persistent efforts of the briber. Worse, however, than this corrupting influence upon the civil service is the effect upon legislation and the legislator. The lobbyist, the advocate of special laws, is the greatest enemy of free institutions. When a people loses confidence in its representatives, when, rightly or wrongly, the latter are held in suspicion of being the tools of private interests, then the calamity is irreparable. The briber of an officer of the Government does momentary harm, while unjust laws tax generations with unjust burdens, that are the more galling the more people become conscious of the methods by which were obtained the industrial preferences and the privilege of taxing the masses for the benefit of the few.

Politics: An Introduction to the Study of Comparative Constitutional Law. By William W. Crane, and Bernard Moses, Ph. D., Professor of History and Political Economy in the University of California. New York: G. P. Putnam's Sons. Pp. 305. Price, $1.50.

This book opens with a description of the structure of a nation and of the nature of sovereignty. The basis of every political community is affirmed to be physical force, and the importance of political instinct is insisted upon. Political heritage is illustrated by the history of the English colonies in America. The means by which the will of a sovereign is expressed are next taken up, the tendency of power in the United States and in some European federations is noted, and a chapter is devoted to political parties.

House-Drainage. By William Paul Gerhard. New York: Durham House-Drainage Company. Pp. 44. Sanitary Drainage of Tenement-Houses. By William Paul Gerhard. Hartford, Conn.: Case, Lockwood & Brainard Company. Pp. 40.

In the former work, the essential features of any thorough system of house-drainage are laid down to be: Extension of all soil and waste pipes through and above the roof; provision of a fresh-air inlet in the drain at the foot of the soil and waste pipe systems; the trapping of the main drain outside of the fresh-air inlet, to exclude the sewer-gases from the house; provision of each fixture, as near as possible to it, with a suitable trap; and provision of vent-pipes to such traps under fixtures as are liable to be emptied by siphonage. In the second pamphlet, the principles of thorough sanitary drainage are applied to the tenement-houses of working-men.

Annual Report of the Connecticut Agricultural Experiment Station for 1883. S. W. Johnson, Director. New Haven: Tuttle, Morehouse & Taylor. Pp. 120.

The Board of Control of this institution report that the people of the State use the station more and more each year, and that the problem becomes more difficult how best to do the varied work asked for. To provide additional force, Dr. E. H. Jenkins has been appointed vice-director. Two hundred and nineteen analyses of fertilizers have been performed, fifteen of milk, three of butter, with negative results as to adulterations, and twenty of fodders. In connection with the last is given a table showing the average composition of American fodders and feeding-stuffs, compiled from all analyses that could be secured up to the 1st of September last. The chief seed-examinations were on onion-seed.

The Glacial Boundary in Ohio, Indiana, and Kentucky. By Professor G. Frederick Wright. Cleveland, Ohio: Western Reserve Historical Society. Pp. 86.

The author began, ten years ago, investigations concerning the kames of the Merrimac Valley in Eastern Massachusetts. Continuing along the line, he has now traced the boundary of the glaciated area from the Atlantic Ocean to the southern part of Illinois. In the present pamphlet, the boundary is described in detail through the several counties and townships of Ohio, with local maps, and as to its general features through Kentucky—so far as it reaches that State—and Indiana.

Real and Imaginary Effects of Intemperance. By G. Thomann. New York: The United States Brewers' Association. Pp. 167.

The brewers have at last entered upon an active defense of their calling, against the assaults of the prohibitionists and the temperance orators, and in this pamphlet present their case and an appeal to facts and statistics. They claim that the arguments that have been hurled against fermented liquors are largely the offspring of the imagination, and do not rest on any solid foundation, or on what can be proved; and they publish counter statements and statistics favoring their own side. Leaving distilled liquors to take care of themselves, if they can, they contend that the beverages in which they are interested are wholesome, and are not instigators of crime, and that the use of them serves as a foil and a check to indulgence in stronger liquors; therefore it ought not to be discouraged.

Mineralogy. By J. H. Collins, F. G. S. Systematic and Descriptive Mineralogy. New York: G. P. Putnam's Sons. Vol. II, pp. 329. Price, $1.25.

The present volume of Mr. Collins's "Mineralogy" is intended to accompany and supplement the first volume, which was published in 1878; and, like that, was written for the use of "practical working miners, quarrymen, and field geologists," as well as of students. The accounts are very brief, but they are clear, and illustrated with distinct drawings of the crystals, and include notices of all the minerals that had been described up to the time of the author's leaving England for Rio Tinto, Spain, in 1881.

Report of the New York State Survey for 1883. James T. Gardiner, Director. Albany: Van Benthuysen Printing-House. Pp. 182, with Six Maps.

The work of the survey was continued through last year in accordance with the matured plan on which it has all the time been prosecuted, and which is calculated, when completed, to produce an accurate and connected system of measurements over every part of the State. The survey of the Tonawanda and Oak-Orchard Swamps has formed a prominent part of it. We learn from the report that the rainfall in Western New York steadily increased from 1830 to 1880, and that the greatest average rainfall known for a similar period—38·73 inches—was reached during the years from 1868 to 1881, inclusive. The summer flow of the streams has, however, greatly diminished during the last fifty years.

The Teaching of Drawing in Grammar-Schools. A Paper on the Educational Features of the Subject. By Walter S. Perry. Boston: The Prang Educational Company. Pp. 26.

This essay was read as a paper before the department of Industrial Education at the last meeting of the American Educational Association. It considers the applications of drawing under three heads: as in industrial construction; in representing the appearance of objects and of nature; and in ornamentation. Of these, in the public schools, the first, the application in construction, is the most important. "It forms pre-eminently the educational and the practical side, and yet it is the one which has usually been ignored, while the picturesque and decorative sides have been given undue importance." It is dwelt upon at length, while the application to representation is treated as complementary to it, and that to decoration as essential to the completeness of the course of instruction.

The American University. When shall it be? Where shall it be? What shall it be? By John W. Burgess, Ph. D., of Columbia College. Boston: Ginn, Heath, & Co. Pp. 22. Price, 15 cents.

In the author's view, the reply to the first question should consist of three conditions. The university shall be when there exists in the nation the surplus of wealth to support it, the body of scholars to form its faculties, and the body of students qualified by previous training and acquirements to profit by university work. These conditions are believed to exist now in the United States. The place for the university should be at or near a center of wealth, education, and refinement, and that exists. The university should not be an institution of the State, but must be a private institution, supported by private donations, and directed by an association of private persons.

Administrative Organization. A Consideration of the Principal Executive Departments of the United States Government, in Relation to Administration. By LL. B. Washington: William H. Morrison. Pp. 108.

Imperfections in the workings of the administrative departments of our Government being recognized, the author of this essay seeks a permanent remedy for them by going to the principles on which departmental organization should rest. He finds that administration of the laws applied to the conduct of public affairs may be evil, by defect of the laws: first, where the administrative organization is in false relation with the administrative object; second, when, though the legal relation be perfect, the processes of administration are faulty; third, when both defects exist. The subject is considered prominently in the former aspect. The first-named defect is declared to exist seriously in the Treasury and Interior Departments, and a plan for reorganizing them is sketched.

Ancient Egypt in the Light of Modern Discoveries. By Professor H. S. Osborn, LL. D. Cincinnati: Robert Clarke & Co. Pp. 232, with Map.

Most good works on ancient Egypt are costly, and the knowledge of the subject is growing so fast that even a very recent book is likely to require to be added to or modified within a short time after it is published. Professor Osborn has endeavored to put what is really known of the history in such a brief form as to embody it in a really accessible book; to sift out what is conjectural and obsolete; and to include the results of the latest researches up to the time of his writing. He has been a diligent student of the monuments and inscriptions in the European museums and in their native land, has kept himself abreast of the literature of the subject, and has endeavored to present the results of matured studies. The work of later years is mentioned, including the discovery of the royal mummies near Thebes, and the excavations of M. Naville at Pithom-Succoth, or the latest that had been done till excavations were begun at Zoan last March. Dr. Osborn's style is not always happy, and his references to the work of later investigators are frequently not so clear as the reader would desire them to be.

Bilateral Asymmetry of Function. By G. Stanley Hall and E. M. Hartwell. Pp. 17.

The subject relates to supposed differences, essential or casual, in the power of similar organs on the different sides of the body; as, between the right and left eyes, ears, arms, or legs, or the right and left sides of internal organs. Numerous observations by different investigators are noticed briefly, and then the present authors describe their own experiments. From them they draw the conclusions that every deviation from perfect bilateral symmetry of form or function is to be accounted for without recourse to occult causes of any sort; that the key to the entire bilateral problem which shall reveal a common principle for all the various paired organs is to be sought in the study of bilateral muscle tension, the only act of will; and that the solution of this problem, when reached, will probably shed light on the nature of consciousness.

The Railroad as an Element in Education. An Address before the State Teachers' Association of Texas. By Professor Alexander Hogg, M. A. Louisville: Printed for the Author.

This brief pamphlet is filled with a great deal of interesting railroad information, its predominant idea being that railroads are a great factor of civilization, and help on the work of general amelioration and improvement in many ways. There is a brief sketch of the course of inventions that prepared for railroad constructions, some examination of the public influence of transcontinental railway systems, some defense of railroads against charges of monopoly, some account of the great "breakwaters" of the world, and finally an argument in favor of the construction of such a work at Galveston, in Texas, that shall give it deeper water and improve it as a seaport.

A Manual of Psychological Medicine and Allied Nervous Diseases. By Edward C. Mann. With Phototype Plates and other Illustrations. Philadelphia: P. Blakiston, Son & Co. Pp. 699. Price, $5.

This comprehensive treatise aims to "present the subject of insanity and allied nervous diseases in a scientific, clinical, and forensic light, and in so concise a form as to be available for the student and general practitioner." It is therefore addressed to the profession as a manual of medical practice, and a systematic text-book of medical education. Physicians must, therefore, be the best judges of its adaptation to their wants, but the work bears evidence throughout of matured knowledge, wide experience, and assiduous, painstaking labor. But while the work is thus designed for the uses of medical men, such is the profound interest and great importance of the questions which it discusses, that in many aspects it will be found instructive and valuable to general readers who are concerned with the great question of the conditions and causes of insanity, and the hygienic precautions that are needed for the maintenance of soundness and integrity of mind. Dr. Mann is evidently no extremist and no alarmist, but he recognizes that mental derangement in various forms is undoubtedly on the increase, and that its extension can be checked only by the widest diffusion of knowledge upon the subject, and some corresponding improvement in those habits of life which are promotive of mental deterioration. Dr. Mann emphasizes in his preface a most important fact, which is too generally overlooked, when he points out the long interval of time that may elapse between the slight initial perversions of cerebral activity and the distant consequences that often result from them. It is too commonly thought that if pupils leave school without becoming lunatics outright, all the talk about mental over-exertion amounts to nothing, yet we have here to do with causes and effects that work slowly, and require time for their full disclosure. Dr. Mann says:

A very important point relating to the prevention of mental disorders and the modern nervous diseases is, that the growth of mental function is as gradual as that of bodily power, and that brain-tissue degenerations and mental diseases may be separated by long intervals of time from the too premature and intense stimulation of the brain in school-children which causes these nervous diseases. We meet with the preponderance of nervous diseases in the refined and cultivated classes, where, by premature and stimulating processes of education, there has been forced an elaboration of brain-structure, hastening the functional activity of the brain, with no due regard to the law of evolutional precedence. Normal growth and development will give us healthy minds, while a structurally degraded centric nervous system, or an altered quality of blood, and secondary disturbance of nerve-function, will antagonize healthy mental manifestation. If we have want of sleep, a defective generation of nerve-force, an unstable condition of the nerve-centers, an incomplete development of any part concerned in mental action, all of which Dr. Blanford, of England, has ably shown to be causes of mental disease, we can not expect healthy mental function. Alcohol and opium are to-day responsible for much deterioration of brain. Dipsomania and the opium-habit being on the increase among Americans, there is a greatly increased nervousness and an increasing inherited disposition to the different neuroses; and the condition known as cerebral hyperæmia, an increase in the quantity of the blood within the capillaries of the brain, or rather one form of it, of vaso-motor origin, resulting from overwork and mental strain, is greatly on the increase.

The Treatment of Wounds as based on Evolutionary Laws. By C. Pitfield Mitchell, Member of the Royal College of Surgeons. New York: J. H. Vail & Co. Pp. 29. Price, 50 cents.

We recently called attention to the lectures of Dr. Hughlings Jackson, before the Royal College of Physicians in London, on the bearings of the law of evolution upon diseases of the nervous system, and in the monograph before us the principle of evolution is followed out in another field of medical practice. The author published a short essay in 1882, in "The New York Medical Journal," in which he "endeavored to find in the Spencerian doctrine of evolution the foundation of a satisfactory theory to guide us in the treatment of such wounds as are inflicted in the more common operations of surgery." The present pamphlet is a further extension of that view. We can only say here that the case is very strongly presented, and will repay the attention of those medical students of a philosophical turn of mind who care for those deeper elucidations and explanations of the living organism which the development theory is now so successfully affording.

Truths and Untruths of Evolution. By John B. Drury, D. D. New York: A. D. F. Randolph & Co. Pp. 140. Price, $1.

This volume consists of the Vedder Lectures delivered in April, 1883, before the students of the theological seminary and Rutgers College at New Brunswick. As might be expected, the author's interest in the doctrine of evolution depends entirely upon its relation to theology. He recognizes that there is some truth in it, which consists in that part that he can conform to the requirements of his theology. He will take evolution as a plausible hypothesis, not yet established as a truth, and which may be a help to scientific progress even if erroneous. He will accept it under theistic interpretation, or as "many Christians hold in conjunction with their faith in God and the Bible."

Dr. Drury examines the definitions of evolution, and, finding them unsatisfactory, remarks: "If I were to formulate a definition of evolution, such as the present condition of our knowledge warrants, it would be this: 'Evolution is that hypothesis which supposes the process by which the present diversity in nature has been reached to have been one of progression; the more complex and better endowed proceeding in accordance with laws imperfectly known out of simpler and lower forms.'"

Undoubtedly the laws will become more perfectly known, and then this germ of a definition will grow into greater completeness. Dr. Drury's book, though emanating from a mind in a state of anxious transition, and beset on all sides with difficulties, is, nevertheless, readable and instructive.

PUBLICATIONS RECEIVED.

Inebriate Automatism. By T. D. Crothers, M. D. Hartford, Conn. Pp. 9.

Filtrations of Saline Solutions through Sand. By William Ripley Nichols. Boston. Pp. 12.

Earthquake Measurement. By J. A. Ewing, B. Sc. Tokio, Japan: Tokio Daigaku. Pp. 92, with Twenty-four Plates.

The Eastern Pioneer of Western Civilization and the Recognition her Efforts receive. By C. S. Eby. Tokio, Japan. Pp. 52.

The Sufficiency of Terrestrial Rotation for the Deflection of Streams. By C. K. Gilbert. Pp. 5.

Osteology of Ceryle Alcyon. By R. W. Shufeldt, U. S. Army. Pp. 15, with Plate.

The Subsidence Theory of Earthquakes. By Samuel Kneeland. Boston. Pp. 8.

Report on the Exhibits at the Crystal Palace Electrical Exhibition of 1882. By Ensign Frank J. Sprague. Washington: Government Printing-Office. Pp. 169, with Plates.

Okadaira Shell-Mound at Hitachi. By I. Iijima and C. Sasaki. Tokio, Japan: Tokio Daigaku. Pp. 7, with Eleven Plates.

Chicago Manual Training School, First Annual Catalogue. Pp. 16.

Evolution and the Positive Aspects of Modern Thought. By W. D. Le Sueur. Ottawa, Canada: A. S. Woodburn.

The Offices of Electricity in the Human Body. By H. B. Philbrook. New York. Pp. 31.

Washington High-School; Syllabus of the Courses in Botany and Zoölogy. By Edward S. Burgess. Pp. 39.

Wages and Tariffs. By E. J. Donnell. New York: Wilcox & O'Donnell. Pp. 47.

"The American Monthly," June, 1884. Chicago, Ill.: American Magazine Publishing Company. Pp. 100. 35 cents, $4 a year.

State Mineralogist, California, Third Annual Report. Sacramento: James J. Ayres. Pp. 110.

Silver-Lead Deposits of Eureka, Nevada. Abstract of report by Joseph Story Curtis. Washington: Government Printing-Office. Pp. 24, with Map and Plates.

The Conventional Lies of Civilization. From the German of Max Nordau. Chicago: L. Schick. Pp. 365. $1.

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Tokio Daigaku. Calendar for 1882–'83. Tokio, Japan: Z. P. Maruya & Co. Pp. 142.

Notes on the Volcanic Rocks of the Great Basin. By Arnold Hague and Joseph P. Iddings. Pp. 12.

Volcanic Sand at Unalashka, Alaska. By J. S. Diller. Pp. 4.

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Eleventh Cincinnati Industrial Exposition, 1883. Report of Board of Commissioners, W. W. Peabody, President. Pp. 312.

Naphthaline as an Insecticide, etc. By Dr. Thomas Taylor. Washington. Pp. 6.

Fibrine and Bacteria. By Thomas Taylor. Washington. Pp. 5.

"American Psychological Journal," Quarterly, Edited by Joseph Parrish, M. D. Philadelphia: P. Blakiston, Son & Co. 1883. Pp. 450. $2 a year.

Alabama Weather Service, May, 1884. Montgomery, Ala. Pp. 9.

Taxation in the United States, 1789–1816. By Henry Carter Adams, Ph. D. Baltimore: N. Murray. Pp. 80. 50 cents.

Criminal Responsibility of the Insane. By Orpheus Everts, M. D. College Hill, Ohio. Pp. 22.

Meteorology and Soil Temperatures at Houghton Farm. By D. P. Penhallow. New York: "The Hub." Pp. 41, with Plates.

The Urine in Disease. By C. F. Taylor, M. D. Philadelphia: "The Medical World." Chart.

Testing Machines. By Arthur V. Abbott. New York: D. Van Nostrand. Pp. 190. 50 cents.

Symbolic Algebra. By Professor William Cain. New York: D. Van Nostrand. Pp. 131. 50 cents.

List of Water-Works. Compiled by J. J. R. Cross. New York. Pp. 8.

The Diet Question: Giving the Reason Why. By Susanna W. Dodds, M. D. New York: Fowler & Wells Company. Pp. 99. 25 cents.

The Hollanders in Nova Zembla. By Daniel Van Pelt. New York: G. P. Putnam's Sons. Pp. 120. $1.25.

Cottages; or, Hints on Economical Building. Compiled and edited by A. W. Brunner. New York: William T. Comstock. Pp. 54, with Twenty-two Plates. $1.

Discoveries of America to the Year 1525. By Arthur James Weise. New York: G. P. Putnam's Sons. Pp. 380, with Map. $4.50.

Tokology: A Book for Every Woman. By Alice B. Stockham, M. D. Chicago: Sanitary Publishing Company. Pp. 277. $2.

The Essentials of Anatomy, Physiology, and Hygiene. By Roger S. Tracy, M. D. New York: D. Appleton & Co. Pp. 299.

Observations on Vitality of Seeds of Weeds, and Certain Diseases of Grasses. Massachusetts State Experiment Station, Amherst. Pp. 12.

Manual of the Mosses of North America. By Leo Lesquereux and Thomas P. James. Boston: S. E. Cassino & Co. Pp. 447, with Six Plates.

The Laws of Health. By Joseph C. Hutchison, M. D. New York: Clark & Maynard. Pp. 223.

Introduction to the Study of Modern Forest Economy. By John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 228.

U. S Commission of Fish and Fisheries. Report for 1881. Washington: Government Printing-Office. Pp. 1,146.

La Fábula de los Caribes (The Fable of the Caribs). By Juan Ignacio de Armas. Havana: Francisco S. Ibañez. Pp. 31.

Fridolin's Mystical Marriage. By Adolf Wilbrandt. Translated by Clara Bell. New York: William S. Gottsberger. Pp. 240.

POPULAR MISCELLANY.

The American Association.—The Philadelphia meeting of the American Association will begin September 4th, under the presidency of Professor J. P. Lesley. The sectional Vice-Presidents are: A. Mathematics and Astronomy, H. T. Eddy, of Cincinnati; B. Physics, John Trowbridge, of Cambridge; C. Chemistry, John W. Langley, of Ann Arbor; D. Mechanical Science, R. H. Thurston, of Hoboken; E. Geology and Geography, N. H. Winchell, of Minneapolis. Biology, E. D. Cope, of Philadelphia; F. Histology and Microscopy, T. G. Wormley, of Philadelphia; H. Anthropology, E. S. Morse, of Salem; I. Economic Science and Statistics, J. Eaton, of Washington. The Permanent Secretary is Professor F. W. Putnam, of Cambridge; General Secretary, Alfred Springer, of Cincinnati; Assistant General Secretary, E. S. Holden, of Madison, Wisconsin; Treasurer, William Lilly, of Mauch Chunk, Pennsylvania. The British Association has invited the members of the American Association to join in the meeting at Montreal, and the American Association and the local committee of Philadelphia have invited the members of the British Association and their companions to take part in the Philadelphia meeting. Receptions will be given at the Academy of Music and the Academy of Fine Arts; a garden-party at Haverford College; and a microscopical exhibition at the Academy of Natural Sciences. Botanical excursions will be organized, and a special meeting for botanists held by the botanical section of the Academy of Natural Sciences; and other interesting visits and excursions will be made. The address of Professor Young, as retiring President of the Association, will be delivered on the evening of the 4th, at the Academy of Music, and will be followed by a reception to members of the Association and their invited guests. The headquarters of the Association will be at the Academy of Music, Broad Street.

Sir John Lubbock on Classical and Scientific Education.—Sir John Lubbock spoke, at a recent dinner of the British University College Club, in reference to the great advance that had been made in this age in education. A commission of inquiry, appointed in 1861, mentioned as a great practical evil of the English schools that too little time was devoted to modern languages, and science was practically excluded altogether. A similar commission in 1864 gave substantially the same verdict. A third royal commission, in 1875, declared that the practical omission of these subjects from the training of the middle and upper classes was little less than a national misfortune. Still, though no doubt some progress had been gained, too little attention was given to these subjects. The time in the schools was at present allotted somewhat on the average as follows: To science, not more than two hours a week were given; to modern languages, three hours; and to geography, arithmetic, and mathematics, four hours, leaving thirty hours for Latin and Greek. Now, suppose that six hours were devoted to arithmetic and mathematics, six to science, six to modern languages and history, and six to geography, there would still be more than twenty hours for Latin and Greek, and if a boy could not learn Latin and Greek in twenty hours a week, spread over ten years, he would certainly never learn them at all. Sir John Lubbock was far from undervaluing Latin, and indeed it seemed to him well worth considering whether the present system of learning it was really wise, and whether our sons ought not to be taught to speak it as well as to read it. He then spoke of the particular importance of the knowledge of modern languages and science in England. Englishmen have the most varied enterprises all over the globe, more than half the shipping on the high seas, and foreign investments returning them $350,000,000 a year. The management of these gigantic undertakings ought to be intrusted to those who could speak the language of the country in which they were carried on. Many a promising concern had been brought to ruin because it had been impossible to find properly qualified Englishmen to take care of it, and because it had consequently been intrusted to foreigners. He did not undervalue and would not neglect the classics. All he asked was that science and modern languages should have their fair share of attention, for, as Dr. Carpenter had well observed, there was one side of our nature which science was the only means of cultivating.

The Weather, Health, and Crime.—Mr. S. A. Hill has recently published, in "Nature," an analysis of the effects of the weather upon the death-rate and crime in India, particularly in the Northwest Provinces and Oude. The whole number of deaths varies enormously from year to year. Thus it was 1,914,499 in 1879, and 987,190 in 1880, showing a difference of nearly a million in two successive years. The average yearly rate is about a million and a half. Taking the two years of extremes cited, in 1879 the monsoon rains were unusually heavy, while in 1880 they were extremely scanty, and apprehensions of famine were entertained. The year 1877 was also dry and healthy. The first rough generalization suggested by Mr. Hill's tables is, that dry years are healthy and wet ones unhealthy. It would, nevertheless, be wrong to infer that in India mortality is due to rain, for the figures for the several months show that, as a rule, the month in which fewest deaths occur is July, which happens to be just the rainiest month of the twelve. Rain is, no doubt, one of the indirect causes of death;

but it operates by inducing malaria, which does not come with it but after it. Mere rise in temperature, as shown by monthly means, appears to have comparatively little effect. The variations in the diurnal range have a much greater effect, while the change in the death-rate, due to varying humidity, is even less than that due to temperature changes. The relation between the death-rate and the movement of the wind is inverse. In October and November, when malarial diseases prevail, the air is almost absolutely still, and a little wind would probably go a good ways toward dissipating malaria. The deaths by small-pox are fewer in the months when the general mortality attains its maximum. The meteorological causes favorable to the spread of this disease appear to be heat, drought, and possibly also an unusually high wind-velocity. The maximum mortality from cholera usually occurs in the rainy season. Whatever may ultimately prove to be the nature of the disease, there can be little doubt that in the Northwest Provinces it is, to a great extent, dependent upon heat and moisture. Crimes by violence seem to be proportional in frequency to the tendency to *prickly heat*, an excruciating condition of the skin induced by a high temperature combined with moisture.

The Morality of Happiness.—If any proof of the truth of your remark, that "there can be no manner of doubt that rules of conduct are regarded by an immense number of persons as essentially associated with religious doctrines," were needed, it may be found in the fact that many people will but half-heartedly admit that a man may be capable of good conduct if he does not profess their own peculiar creed, but will stoutly deny that such conduct is possible to him who professes no creed at all. The reason for this position is, I think, not far to seek. That conduct conduces to happiness is, perhaps, more conclusively insisted upon in the Bible than in any other book that is equally read; and those who regard the Bible as the inspired fount of their theology can not admit that a man may by his life prove this and yet not give his adhesion to their own or some kindred doctrine which they insist is built upon biblical teaching. But that this proposition—"Conduct conduces to happiness"—is true, most people, indeed, I should say, all people, may prove to themselves by a little thoughtful introspection. Who, without any reference whatever to religious sentiments, has not felt the pangs of remorse, when suffering from a sense of wrong-doing? Who has not felt a thrill of the most real and satisfying pleasure when, by the exercise of self-denial, he has conferred some benefit on a fellow-creature—thus receiving from his own conscience the direct assurance that the proposition is true? Yet conscience existed before the Bible, and before the Bible must have been susceptible of the same emotions that influence it now. It so happened that the Jews made the discovery, some centuries ago, that "conduct conduces to happiness," and insisted upon it in their literature; and it further happened that upon Jewish literature the whole fabric of Christian theology was built up; but the truth and proof of the proposition are matters of purely worldly wisdom, the outcome of experience, and have nothing whatever to do with theological dogmas.—*A. McD., in Knowledge.*

Flat-foot.—Flat-foot is an acquired deformity, characterized by a flattening or falling down of the inner longitudinal arch of the foot, a structure on which depend the form of the foot, the distribution of the weight of the body over it, and the grace and ease of walking connected with the rising forward on the toes. Its cause may be found in any condition that disturbs the natural equilibrium between the weight transmitted to the arch and the power of the fibrous and muscular structures to sustain the pressure. It comes on about puberty, or between puberty and full manhood, particularly in persons exposed to long standing, carrying heavy weights, or other modes of straining the arch, and in those whose tissues are weak at that point. Besides the deformity and the loss of elasticity in the step and of all ease and grace in walking, it causes great pain, which, naturally, is always worse after standing or walking, especially after going up-stairs or up-hill, and at night than in the morning. In very severe cases the heel becomes raised, giving the foot what Professor Ongston has called a canoe-shape. The success of any treatment of the deformity depends largely upon the age and extent of the affliction and the ability of the patient to conform to the surgeon's directions. It includes prolonged rest, the avoidance of standing still, the exhibition of tonics, the adaptation of boots to the requirements of the case, with the application of devices to raise and support the arch or bring the other parts of the foot into proper position, with, sometimes, surgical operations. Professor Ongston, availing himself of the advantages of Listerism, has ventured, with success, upon the bold operation of rearranging the bones of the foot in their proper position and plugging them together with ivory pegs.

The True and False in Mesmerism.—The physiologist, says the "Saturday Review," holds that some of the phenomena of mesmerism are genuine and comparable to certain natural states, but that none exist to justify the supposition of any unknown force or effluence, most mesmeric manifestations of a certain sort being entirely due to individual or collusive fraud. For most of the facts alleged are of such a nature that it is infinitely more probable that all connected with them, both actors and reporters, are deliberate impostors, than that they themselves should be true. The careful study of the alleged phenomena by those who are alone qualified to report on them has over and over again negatived all shadow of evidence that a person in the state called hypnotism, somnambulism, or mesmerism, has any power whatever of being influenced in any way by another to perform *specific* actions, all possibility of previous hints or impressions being excluded, while demonstrably apart from all methods of communication by the senses. That in many cases the mind may act abnormally most are aware, and spontaneous counterparts are found in disease to the real phenomena of hypnotism. Artificial somnambulism, indeed, is practically undistinguishable from the somnambulism which is called disease; and it is mainly true to regard the psychological fields of these phenomena as identical. In this state the brain acts, as it were, fitfully; some of its functions sleep while others wake, and in various combinations the actions of the senses are heightened or lowered, or apparently for a time abolished. But in no instance of this artificial somnambulism that has been admitted to be genuine has there been any justification for supposing a special effluence from the operator; and innumerable counter-experiments have been made on hypnotic subjects who have promptly fallen into this condition from merely believing that some force was being exerted. Every hypnotic phenomenon can be more or less obviously referred to morbid conditions of the nervous system and to abnormal reaction or response to suggestions and other stimuli from without. Illustrations of this are not far to seek. We know that lunatics, out of harmony as they are with their own environment, often imagine themselves to be other people, especially kings and queens. So do the subjects of hypnotism at the suggestion of external surroundings; in the one case the morbid condition is temporary, in the other often permanent. The explanation, then, of the phenomena in question, is to be sought not in the person of the mesmerizer or operator, or in any unknown force, but in the subject "mesmerized." The common element of mesmerism and spiritualism, and it is indeed a large one, is really fraud and fraud alone. Of what remains, the genuine fact of hypnotism, it must be repeated, that it is amply recognized by scientific observers.

Nickel-Plating in the United States.—"Nickel-plating," says Mr. William H. Wahl, in a paper read before the Chemical Section of the Franklin Institute last November, "is an American industry, in the sense that it was first practiced on a commercial scale in the United States, and here received that practical demonstration of its usefulness that has since made it the most successful and most widely practiced branch of the art of electro-plating." It first came into prominence about ten years ago, and has developed into an industry of great magnitude, and acquired a popularity which is easily accounted for by any one acquainted with the use and the excellence of nickel-plated articles. Its growth has been favored by the success which Mr. Joseph Wharton has attained in the production of metallic nickel of suitable purity at a reasonable price. Mr. Wharton was one of the first to work the metal successfully, and exhibited at Vienna, in 1873, samples of axles and axle-bearings, and at Philadelphia, in 1876, a remarkable series of objects of wrought-nickel. He produced in his works, between 1876 and the close of 1882, 1,466,765 pounds of the metal, the principal source of supply of which was from the ores at Lancaster Gap, Pennsylvania. The earliest practical process for nickel-plating in the United States was patented by Isaac Adams, Jr., in 1869. He devised a bath of the double sulphate of nickel and ammonium and the double chloride of nickel and ammonium, with anodes of metallic nickel, in which iron was combined, to obviate the bad effects of copper and arsenic impurities. The extensive application of this process was facilitated by the production of nickel of improved qualities of purity, and the introduction of dynamos for producing the electric currents, they taking the place of the expensive galvanic battery. Edward Weston, in 1878, prepared a solution containing boric acid, with the double sulphate of nickel and ammonium, the superiority of which is generally recognized. The deposited metal is almost silver-white, dense, homogeneous, and tenacious, while the solution maintains a uniform, excellent working quality. Among other solutions which have been introduced, one prepared by adding ammonia and water to the sulphate of nickel, is recommended by Professor Böttger, and is said to be well suited for the purposes of amateurs, because of its giving good results with a platinum anode. Compositions containing sulphate of nickel and ammonium and sulphate of ammonium are recommended for coating several different metals. Where the double sulphate of nickel and ammonium is used, the bath should be maintained as nearly neutral as possible; but it may be either slightly acid or slightly alkaline. The strength of the current should be carefully regulated according to the surface of the articles in the bath, or the work will be apt to "burn," when the metal is precipitated as a dark-gray or black deposit. To obviate this difficulty, a plate of nickel presenting considerable surface is suspended from the rods by which the objects to be plated are held in the bath, to divert the surplus of the current from them. Other things being equal, the slower the rate of deposition, the more adherent and tenacious the coating of deposited metal will be. Success in plating depends very largely upon the perfect cleansing of the articles before they are immersed in the bath; and this is more important in case of plating with nickel than with other metals, for which the solutions are generally more alkaline. As nickel-plated articles can not be burnished on account of the hardness of the deposited metal, they should be thoroughly polished before being exposed to the bath. A good coating of nickel properly laid on preserves great durability.

A People who can not make Fire.—The Papuans of the Maclay coast of New Guinea are represented by the Russian explorer, Dr. Miklucho Maclay, as being in the most primitive stage. They are wholly unacquainted with metals, and make their weapons of stone, bones, and wood. They do not know how to start a fire, though fire is in use among them. When the traveler asked them how they made a fire, they could not understand his question, but they regarded it as very amusing, and answered that when a person's fire went out he got some of a neighbor, and, if all the fires in the village should go out, they would get it from the next village. Some of the natives represented that their fathers and grandfathers had told them that they remembered a time, or had heard from their ancestors that there was a time, when fire was not known, and everything was eaten raw. The natives of the southern coast of New Guinea, having no iron, shave themselves now with a piece of glass. Formerly they shaved with flint, which they could sharpen quite well, and used with considerable dexterity.

The Art of Early Rising.—The proper time to rise, says the "Lancet," is when sleep ends. Dozing should not be allowed. True sleep is the aggregate of sleeps, or is a state consisting in the sleeping or rest of all the several parts of the organism. Sometimes one and at other times another part of the body, as a whole, may be the least fatigued, and so the first to awake, or the most exhausted, and therefore the most difficult to arouse. The secret of good sleep is, the physiological conditions of rest being established, so to work and weary the several parts of the organism as to give them a proportionally equal need of rest at the same moment; and, to wake early and feel ready to rise, a fair and equal start of the sleepers should be secured; and the wise self-manager should not allow a drowsy feeling of the consciousness or weary senses, or an exhausted muscular system, to beguile him into the folly of going to sleep again when once he has been aroused. After a very few days of self-discipline, the man who resolves not to doze, that is, not to allow some sleepy part of his body to keep him in bed after his brain has once awakened, will find himself, without knowing why, an early riser.

Reafforesting of Ireland.—At the suggestion of Dr. Lyon, M. P. for Dublin, Mr. D. Howitz, Forest Conservator of Denmark, has made an examination of the resources and the need of Ireland for forest cultivation, and his observations and conclusions have been embodied in a parliamentary report. He has found that "swamps and morasses are created in Ireland from the want of trees to drink up the superfluous moisture. Irish rivers inundate the districts they traverse because there are no forests on the mountain-tops to arrest and retain the autumn and spring rains. In summer there is a dearth of water because the trees are gone which would have served, each, as a reservoir. . . . Irish agriculture, by its system of straight drains, which Mr. Howitz entirely disapproves, has acted as if water were poison instead of nutriment. In the past by felling the mountain-woods, and in the present by planting no successors, it has done worse by tapping the supply at its source. Irish fruitfulness is gradually being drained and washed away into the lakes and seas, and no preparation has been made to replenish it." Yet the island presents the especial conditions for rendering forestry easy and beneficial. Five million of its twenty million acres are waste, and might be planted with a reasonable certainty of profit; and these lands would grow valuable timber, instead of the commoner and cheaper kinds. The list of available trees includes thirty-six conifers, thirty-eight deciduous and hard-wood species, and eight sorts of bushes. Mr. Howitz has drawn up from personal inspection a scheme for planting a hundred thousand acres every year for the next thirty years. By the end of that time a plantation, he estimates, will come to full productive capacity, besides having already given incidental returns from brushwood and saplings. The cost per acre, at the end of thirty years, will have been, at the highest, £20, or $100; while the lowest annual profits are computed, at present prices, at one pound, or five dollars per acre; and as the demand for timber is all the time rising, and the area of supply narrowing, they are likely to be higher.

The Training of a Medicine-Man.—The medicine-man among the Indians of French Guiana, who is called the *piaye*, is priest, doctor, wizard, and mountebank, chiefly the last, all in one. He prepares himself for his office by going through a course of special training, full of terrible experiences, to which he submits willingly for the sake of the advantages he expects to gain. The candidate, who is supposed to have had some kind of a call to the office, must obligate himself to submit, without flinching, to all the processes of discipline that are to be imposed upon him. Except for a little instruction in the concoction of poisons, the discipline has no reference to the medical art. For six months he is put upon a diet of manioc, which he must feed himself with his feet, using his hands only to guide his feet to his mouth; then he is allowed dried fish, to be taken in the same way, and tobacco, of which he must swallow the juice. Having survived this for a year, he is "examined" by being held under water till he is almost strangled, and then made immediately to walk over red-hot coals, deliberately. Another year of the former regimen is given him to prepare for his second examination, when he is tied up in a bag full of red ants, previously well shaken to a pitch of savage excitement. He is next treated to a most ingeniously devised application of wasp-stings, and to a trial of snake-bites, against which he is permitted to fortify himself with antidotes. He may also be hung to a flexible rod by hooks stuck in his ribs, or by his thumbs and toes, and kept awake for a week at a time. After this course, he is permitted to assist his master by beating the drum around the sick man's hammock, and howling to drive away the evil spirits. His final trial is the drinking of a decoction of carrion and tobacco-juice, after which he is regarded as fully qualified to work upon the fears of the tribe, and extort from them all the service and tithes and tribute, and levy all the black-mail his victims can be forced to pay. As for medical treatment, there is none of it, not even the herb-doctoring; and this constitutes the chief advantage of the system.

Treatment for Inebriate Patients.—At the last meeting of the American Social Science Association, T. D. Crothers, M. D., read a paper in which he stated that, by a strange shifting of events, insanity, which was supposed to be a spiritual affection until a comparatively recent date, is now studied as a physical disorder; while, inebriety, which was regarded as a disease twenty centuries ago, is still invested with the superstition of a spiritual origin. If it were a moral disorder, it would diminish with the growth of morality and intelligence, but, notwithstanding the advance in these directions, it is rapidly increasing. The revenue returns for twenty years bring out this fact clearly. In 1862 the revenue collected from liquors was six millions; in 1882 it had reached eighty-six millions, an increase far beyond that of the population; yet this does not indicate the enormous increase in sales by the local dealer, of which there are no records. The law assumes the correctness of the theological theory of inebriety, which affirms it to be a vice. The remedy, of course, is punishment by fine and imprisonment, which never cures or prevents drinking, but, on the contrary, weakens and enfeebles the victim, rendering him less curable. Very much in the same way, the punishment of insanity and witchcraft always made its victim worse. The hygienic influences of jails and prisons are wanting in every respect, and adverse to any general healthy growth of body and mind. The only compensation to the inebriate is the removal of alcohol, and the state, in doing this, most terribly unfits him, and makes him more helpless for the future. The hereditary nature of many cases of inebriety is well established. It is estimated that over sixty per cent of all inebriates inherit a defective brain and nerve organization. Moderate drinking always leaves an impress on the next generation. In heredity from inebriety there is transmitted a special nerve defect, which, from certain exciting causes, will always develop into inebriety, or one of its family group of disorders—consumption, insanity, pauperism, criminality, etc. Another form of injury that is obscure, but equally prominent as a cause of inebriety, is mental shock, that is, the effect of sudden grief, alarm, loss, sorrow, or other depressing emotion, which brings on a form of nervous derangement that finds relief in the narcotic effect of alcohol. Children from inebriate, insane, or defective parents require a special education. It is a fact beyond all doubt that the education of to-day, applied irrespective of the natural capacity of the person, and along unphysiological lines, literally destroys and unfits a large class for healthy and rational living. Probably the largest class of inebriates in this country is without means of support. Dr. Crothers recommends that this class should come under legal recognition, and be committed to workhouse hospitals located in the country. These hospitals should be training-schools, in which medical care, occupation, and physical and mental training could be applied for years, or until the inmates had so far recovered as to be able to become good citizens and self-supporting.

Old-World Origin of the American Indians.—M. Dabry de Thiersant, a French author, has published a book on the "Origin of the Indians of the New World and of their Civilization," in which he asserts that "everything authorizes the supposition that the New World was peopled, at an epoch difficult to determine, by colonies of the Mongolian race, coming over by way of Behring's Strait or of the Aleutian Islands." They were followed by the immigration of another race which played an important part in the development of American civilization, an Aryo-Turanian race, from Scythia. The author describes the probable steps of these immigrations, and assigns the part the Aryans took in the construction of the ancient civilization of the country, in plausible conjectures, which, however ingeniously drawn and stated, lack the essential quality of being known facts. He might, however, have had some substantial foundations on which to rest his hypotheses, had not the Spanish conquerors taken the pains to destroy all the monuments and records they could place their hands upon.

The Mask-Dances of New Ireland.—Herr Weisser, who has recently been cruising in the South Sea Islands, has communicated to Dr. Bastian some interesting facts respecting the use of masks by the savages of New Ireland and some of the neighboring islands. A kind of feast of masks takes place once a year, in the early days of May, and is made an occasion when hostile tribes meet each other in peace for that day only—and, possibly, for finding pretexts for another year's hostilities. Tribes that are neighbors are constantly at war with each other, and hardly a week passes but some person of one of the tribes is killed and eaten by members of another. Such is the course of life through the year, till the festival of peace and masks. During this time the brave carves out, adorns, and paints his mask according to his own notion, and generally with considerable artistic skill. Hence the masks in a large tribe will exhibit a great variety of patterns. Great care is taken that no one shall see the mask, for it is very important that the identity of the owner shall be concealed. When the work is finished, the owner puts his mark on it, and takes it to the mask-house. When the time comes for the parade of the masks, the champions put them on, having arrayed themselves for the occasion in red shirts of bark, and skirts reaching to their knees. They then go out armed to the neighboring tribes, giving notice of their approach by the blowing of conchs and the beating of their wooden drums. When the hostile tribe is reached, the mask-dance is executed with a set of extraordinary movements, and then they all fall to eating together, not without some restraint, for instances of treachery have been known in which poison was concealed in tempting looking sago-cakes. Peace lasts till night, when the masks are inspected, compared, criticised, and jeered at with every manifestation of contempt. The last part of the proceedings excites mutual anger, and furnishes the occasion for the next year's hostilities.

Why we walk in Circles.—The reason that, when lost or not able to see, we walk in a circle, is still undetermined. Mr. George H. Darwin believes that it is because we are right or left legged, our "leggedness" being generally the converse of our "handedness," and that therefore right-handed men, being left-legged, are most apt to deviate to the right, and left-handed men to the left. Himself and Mr. Galton and others, making personal experiments in walking blindfolded, found themselves describing circles not more than fifty yards in diameter, to the right. Of eight schoolboys, six, who were totally right-handed, strode longer from left to right than from right to left, hopped on the left leg, and rose in jumping from that leg; one boy pursued the opposite course; and the last walked irregularly, with no average difference between his strides. Walking on a match for straightness, the left-legged boys all diverged to the right, the seventh boy to the left, and the eighth won the prize. Measurements of Mr. Darwin's own stride, and of the strides of his friends, showed the same connection between divergence and comparative length of stride. Mr. Thomas Hawksley believes that the reason for the divergence is to be found in differences in the length of the legs, not enough to affect the visible step, but sufficient to reveal itself in a considerable walk.

Siberian Superstitions.—A Russian officer, who has spent several months in that region, has given a curious picture of the Yarchans, or the people of Yarkino, in Northern Siberia, who, while in the organization of their communal life they conform quite closely to the Russian system, have so little communication with the world that they still remain almost in a primitive condition, and the grossest superstitions prevail among them. When the moon is eclipsed, they think it is bewitched; they regard green trees as living and having souls; and they consider sickness a kind of foreign, baleful element that has intruded itself into the organism. Sleep is conceived to be something apart and independent of the body, and the idea of disturbing sleep is incomprehensible to them. They think that, if a man has sleep, he will keep on sleeping in spite of all that can be done, but that, when sleep has left him, the slightest movement will arouse him. They believe in spirits of the wood, and of the tree, fire, house, and bath, not with the abstract, half-belief of the Russian peasant, but with a full confidence in their existence as practical realities. "I am convinced," says the Russian officer, "that the Yarchan peasant is accustomed to begin nothing without previous incantations and mysterious manipulations. Father Wood-Spirit is besought not to drive away the squirrels during the hunt; the spirit of the bath is asked for permission to go into the bathing-place; and the Yarchan is not willing to go to his bath alone for fear of being troubled by the spirit. So permission is asked of the wood-spirit before felling a tree. All petitions of this kind are accompanied with peculiar symbolical formulas. Incantations are in use for the gun, in behalf of the cattle, against diseases, and for every occupation of the day and hour. Of course, there is little room for rational medicine among such a people, and incantations, holy water, and amulets are chiefly relied upon to meet the effects of bewitching. A wizard's cap was formerly set up on the road leading to Yarkino, to prevent the entrance of plagues and witches. The town clerk had it taken away, and the whole community complained of the act to the official board. A wood-fire—that is, a fire that has been kindled by rubbing two sticks together—plays an important part as a prophylactic against infections and all kinds of disease. When an epidemic breaks out, the use of matches is forbidden, all fires are extinguished, and a new wood-fire is kindled in the street, whence all the household fires must be replenished. If, while this is going on, any fire is lit by means of matches or flints, the procedure is vitiated, and has to be gone over again from the beginning.

Virchow on the Origin of Bronze.—At the recent meeting of the German Anthropological Society in Treves, Professor Virchow spoke on the origin of the bronze age. Some archæologists supposed that the composition of the bronze alloy was discovered at different places and in different times independently of one another; but against this view was the fact that the composition of the bronze found everywhere, from the Caucasus to the Pillars of Hercules, is identical—nine parts of copper to one of tin. Considering the question of original discovery, the speaker did not regard the evidence in favor of the claim of the Phœnicians as strong enough to justify the ascription of the honor to them, though they may have been active as spreaders of bronze. Hochstetter's theory that the metal was the property of the whole Aryan race, and had been their common possession before they left their Asiatic home, was opposed by geographical and archæological considerations. Nevertheless, Professor Virchow believed that the civilization of Central Europe was the development of Aryan influence.

The Ideal Zoölogical Garden.—Mr. Theodore Link protests, in "The American Naturalist," against the usual arrangement of zoölogical gardens. As distinguished from menageries, or "shows," the object of zoölogical gardens, according to the constitutions and by-laws of most of them, is the study and dissemination of a knowledge of the natural habits of the animal kingdom. To fulfill this definition, the gardens should furnish opportunities for the study, "and these the disappointed zoölogist seeks in vain. In fact, in this respect, the zoölogical garden of to-day affords but few more advantages than any of those traveling shows that come here every season. . . . I have simply found that an animal, as closely confined as most of them are in zoological gardens, retains none of its natural habits; it only exists—a mere automaton; and even this existence is seemingly under protest. Therefore this aforesaid 'study and dissemination of a knowledge, etc.,' is 'a delusion and a snare.'" In the zoölogical gardens, as he conceives it, "the foremost condition will be the rational construction of inclosures—not cages—liberal in extent, and in strict accordance with the respective habits and instincts of the animals to be confined. Cages can not well be avoided by traveling menageries; in zoölogical gardens they are inexcusable." In the landscape features of a zoölogical garden, the aim should be to unite beauty with use. The surroundings should imitate, as near as the climate permits, the scenic characteristics of the homes of the various specimens. "This would be a pleasant delusion to both visitor and animal. These widely different styles of scenery should, of course, be blended into a harmonious and well-balanced composition by a very guarded and gradual transition, thus affording delightful surprises at every step."

The One Hundred Cataracts of the Iguazu (South America). — One of the most remarkable systems of waterfalls in the world is described by Herr Gustav Niederlein, who last year made an exploration of the Paraná River into the Argentine province of Misiones. The falls are called the One Hundred Cataracts of the Iguazu, a stream which at that point defines the boundary between the Argentine Republic and Brazil. The river, which is about three miles wide at a short distance above, falls from the Albert Archipelago in a three-quadrant arc, which is compared with that of the Victoria Falls, a descent of about one hundred and seventy feet. The falls appear in three divisions, called the Brazilian, Island, and Argentine Falls, or as Herr Niederlein prefers to style them, the Emperor Dom Pedro, the Emperor William, and the General Roca falls. The first excel in grandeur, the last in beauty, while the Emperor William falls, less extensive, and situated between the other two, impinge upon the handsomely wooded Emperor William's Island. The Dom Pedro Fall plunges a sheer depth of forty or fifty metres into a narrowly contracted basin, whence flows the Brazilian arm of the Iguazu, into which farther down the island-cataracts pour their masses. The bow-shaped Argentine Fall is broken into two stages, the upper one of which is divided by the interposition of a rocky mass into two minor bows, so that it is really a kind of triple fall. This triple cataract feeds the smaller Argentine arm of the river, which joins the Brazilian arm farther on. Not far from these falls the stream receives from the Argentine side the two Bosetti Falls, which, issuing from side-clefts, throw their water-masses over a ledge, about fifty feet high, upon a rocky platform, whence they immediately plunge into the Iguazu. Still below these are fourteen smaller falls, and, finally, the Prince Bismarck Cataract, which falls with a descent broken into two falls, about one hundred and twenty-five feet into a gulf fringed with the primitive sub-tropical forest. About ten miles below this, the Iguazu, now about six hundred and sixty feet wide, unites with the Paraná.

The Southern Andes and Patagonia.—Dr. Karl Martin, of Jena, has recently published a description of the Patagonian wilderness and the lower Andes, from his own observations. The Andes do not stretch in a continuous chain to Cape Horn, as is often supposed, but are broken south of Central Chili by several interruptions. Down to the volcano of Villarica, in south latitude 39°, they are a solid range; but below that peak the mountains fall far below the sixteen thousand feet which it attains. From its southern slope the Shoshuenco River, the chief affluent of the Valdivia, penetrates the mountains through a pass of only about thirteen hundred feet above the sea, receiving its water from a lake which is separated only by a low ridge from the waters of the Limai, a stream flowing into the Atlantic. The mountain standing between this and the next pass of three thousand feet in height is 8,700 feet high, while south of it are lower mountains, between which a number of little known but not very elevated passes lead into the Patagonian highland. A view from the hills surrounding the city of Osoruo shows a number of considerable mountains with no connecting ridge between them, and, in the south, a chain of three peaks. One of these peaks, the shapely cone of the volcano of Osoruo, rises from between two lakes, into one of which flows from the east the Puella, a stream whose source is in the glacier of the Tronador, ten thousand feet high. Near it and separated by a pass of only twenty-nine hundred feet high, flows the Rio Frio from another glacier, into the Nahuelhuapi Lake, the largest lake in Patagonia, from which the Limai, the principal river of the country, flows to the Atlantic Ocean. The chain of the Andes is again broken at this point by a deep gorge; and the passes continue to diminish in height as we go south. The idea that the Patagonian Andes form a continuous marked boundary to the table-land of the country is a mistaken one. The line is frequently broken by ravines that reach far back into the interior; and Captain Simpson, of the Chilian marine, has found the sources of two of the principal western rivers not far from the center of the country. At other points the sea makes extensive cuts into the land, forming deep bays and fiords, between which the land pushes out its sharply serrated peninsulas. Archipelagoes, in which Simpson has counted more than a thousand islands, lie before and within the bays. The largest of the islands is Chiloe; a few of them are level, but most of them are mountainous and steep, while all are thickly wooded. The coast-lines are sharply indented, and the slopes in the neighborhood of the Straits of Magellan, those of Cape Froward, Tierra del Fuego, and Cape Horn, with whose cincture of evergreen beeches the verdant mantle of the Patagonian wilderness descends to the sea, are very rugged.

Effect of Sewage on River-Water.—Franz Hulna has examined the water of the river Oder above Breslau, in its course through the city, and for fourteen kilometres, or about ten miles, below the town, to determine the effect of sewage upon its purity. From the point where the water-supply of Breslau is pumped up to a little above the town, the water undergoes a slight but appreciable deterioration, but after filtration is quite suitable for domestic uses. In passing through the city a continuous change for the worse takes place, which is manifested by the increase of oxidizable matter and of chlorine, and by a hundred-fold augmentation of ammonia and albuminoid ammonia. Microscopic examination disclosed the abundant presence of organisms of putrefaction. Farther down was observed a gradual process of self-purification by contact with oxygen, along with the co-operation of vegetable and animal life in the stream. At fourteen kilometres below the city the influence of sewage could not be detected, either by the chemical or the microscopic examination; but the water was of the same composition as at the supply-station above.

NOTES.

At the June meeting of the Iowa Academy of Science, the president, A. R. Fulton, exhibited specimens of native copper, found in the drift of Iowa, which were in all respects similar to the native copper of the Lake Superior region. In his accompanying paper, Mr. Fulton accounted for their occurrence in this situation by saying that the Lake Superior region was undoubtedly their original home, and that they had been transported by the ice-stream of the Glacial epoch, which apparently at some time had flowed in a southwesterly direction. The occasional finding of fragments of the common sulphate of lead in the drift, southwest from the lead-region about Dubuque, would indicate the same movement.

Professor Moerta, formerly director of the observatory at Santiago, Chili, died at Dresden, Saxony, April 2d, in the fifty-ninth year of his age. He was born near Cassel, and educated at Marburg. He went to Chili, where our Gilliss was making observations on the solar parallax, in 1850, and eventually participated in the observations. When Gilliss returned home in 1852, the Chilian Government put him in charge of the observatory. He also held a professorship in the university. He returned to Europe in 1865, charged with a commission by the Government to purchase a telescope, but did not go back to Chili on account of his health. His observations are embodied partly in the "Annales de la Universidad de Chile" and partly in the "Astronomische Nachrichten."

M. J. P. L. Girardin, a French chemist of considerable distinction, died early in June, in the eighty-third year of his age. He was for thirty years Professor of Chemistry applied to the Arts in Rouen, where he made special researches in fertilizers, and introduced improvements into the processes of the manufactures carried on there that proved to be of great importance. He was afterward a dean of the Faculty of Lille, and rector of the Academy at Clermont. He published some considerable works, the most important of which was his "Lessons in Elementary Chemistry" in five volumes.

Dr. Lee, of England, asserts that carbolic acid is the best substance for disinfecting the air, because, when combined with water and boiled, it evaporates with the steam in a constant ratio, so that the steam contains the same relative quantity of the acid as the water from which it is evaporated. Consequently, the acid can be evenly distributed to the air in a constant and exactly regulated proportion, a property which no other equally efficient disinfectant possesses in so perfect a degree.

Mr. Charles Watkins Merrifield, F. R. S., whose especial field was in mathematics and the exact sciences, died at Hove, England, January 1st, aged fifty-six years. He was for many years Honorary Secretary of the Royal Institute of Naval Architects. He became Vice-Principal of the South Kensington School of Naval Architecture and Marine Engineering in 1867, and was afterward made principal of that institution; and was Vice-President of the Mechanical Section of the British Association in 1875, and President of the same in the following year. He made the report of the Association on the stability and propulsion of sea-going ships in 1869; was President and Treasurer of the London Mathematical Society; and was an author and editor of mathematical textbooks.

According to the estimates of botanists, trees are capable of very long life. De Candolle gave the age of an elm at 335 years. The age of some palms has been set down at from 600 to 700 years; that of an olive-tree, at 700 years; of a plane-tree, at 720; of a cedar, at 800; of an oak, at 1,500; of a yew, at 2,880; of a taxodium, at 4,000; and of a baobab-tree, at 5,000 years.

An electric light has been put in the lighthouse on Razza Island, at the entrance to the harbor of Rio de Janeiro. It has an intensity of 120,000 carcels, or sixty times that of the best oil-lamp. It is visible by its reflection in the sky, so visible as to attract the attention of those who were not aware of its existence, for a distance of thirty-five miles, or three miles and a half beyond the farthest point at which it can be seen by direct vision, and for a mile farther out to those who know where to look for it.

Travelers have sometimes told of swarms of lepidopterous insects appearing on vessels at sea at certain distances from the coast of South America, and have supposed that they were brought from the pampas by the southwest wind, called the *pampero*. Dr. Fromont, of Brussels, has given an account of a swarm consisting of several varieties of insects that made their appearance when the wind was blowing against the coast, and had to be accounted for in some other way. On looking into the hold, there were found, among the bananas and other fruits with which the vessel was loaded, many remains of chrysalises and chrysalises ready to burst; and it was obvious that the insects had been developed in the cargo. Larvæ of coleopterous insects are also believed to be packed with the dried meat that is shipped from Buenos Ayres, and to give rise, in due time, to other unpleasant appearances.

M. Nefedot has received a gold medal from the Natural Science Society of Moscow, for his account of a flint-implement factory found by him in the Vetlouga district, government of Kostroma, the first establishment of the kind of which remains have been discovered in Russia. He has collected six thousand specimens of cut flints and other objects of the stone age, including articles in bone and clay. They are all remarkably primitive in character and form, and none polished.

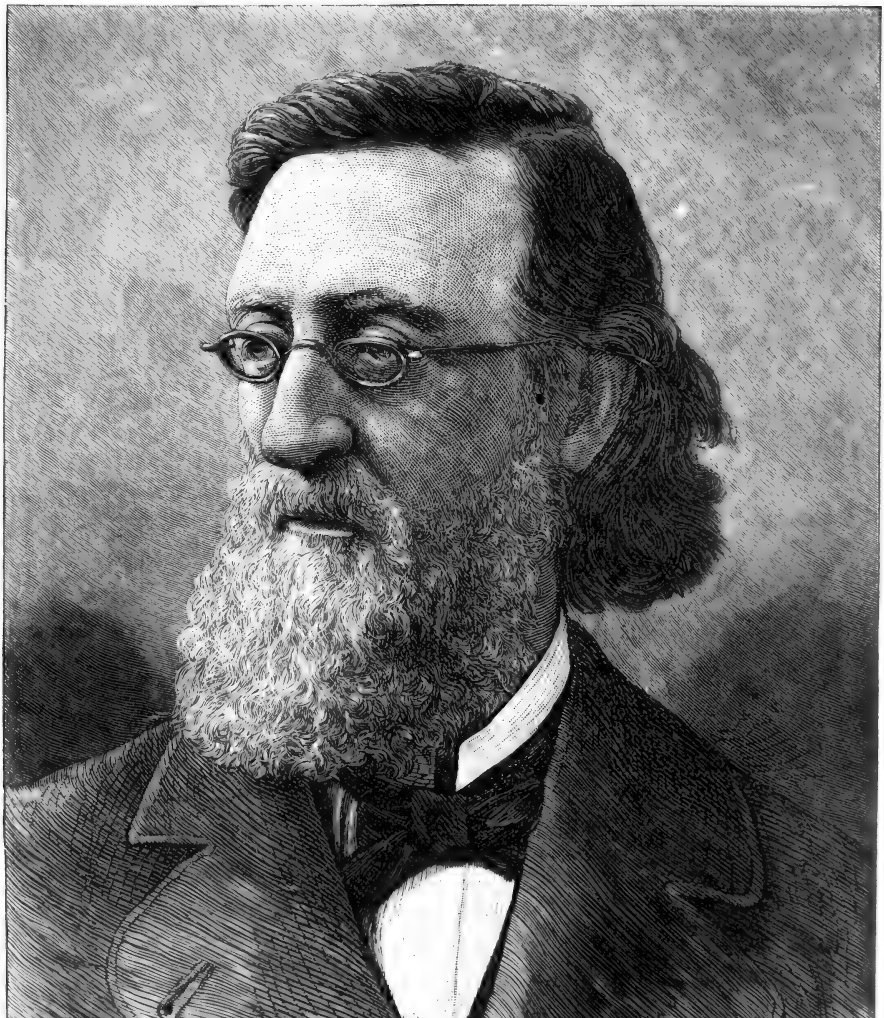
Specimens of paper and pasteboard made from the old moss of the Scandinavian bogs have been offered in the markets. The pasteboard is as hard as wood, and is easily painted and polished; and it is believed to have, for certain purposes, advantages over wood, of which it has the best qualities without the faults. It does not split or warp. Under the hydraulic press it acquires a consistency and a resisting power much superior to what can be given to pasteboard of straw.

Sir Joseph Fayrer, President of the British Medical Society, is authority for the story that in nearly every Himalayan village the native baby is placed in a trough into which a stream of water is constantly trickling. This falling upon the vertex of the cranium induces sleep, in which children will lie in their troughs for hours, while their mothers are at their work.

An Assyrian record of a transit of Venus in the sixteenth century B. C. has been deciphered by Professor A. H. Sayce.

The Harvard students have now had the direction of Dr. D. H. Sargent in their physical training, and the use of the Hemenway Gymnasium, over four years. The averages of the relative development and strength of the ten strongest students using the gymnasium each year, computed from Dr. Sargent's elaborate tests and measurements, show a rapid advance during this period:

	Age.	Weight.	Development.	Total strength.
		Kilos		
1880	21·6	72·2	528·7	655·2
1881	21·1	73·9	583·7	676·9
1882	20·9	69·4	526·9	854·6
1883	21·1	71·8	583·2	898·4
1884	21·6	70·8	541·4	1018·0



J. PETER LESLEY.

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SCIENTIFIC CULTURE:

ITS SPIRIT, ITS AIM, AND ITS METHODS.*

BY JOSIAH PARSONS COOKE.

I ASSUME that most of those whom I address are teachers, and that you have been drawn here by a desire to be instructed in the best methods of teaching physical science. It has therefore seemed to me that I might render a real service, in this introductory address, by giving the results of my own experience and reflection on this subject; and my thoughts have been recently especially directed to this topic by the discussion in regard to the requisites for admission, which during the past year have actively engaged the attention of the faculty of this college.

At the very outset of this discussion we must be careful to make a clear distinction between instruction and education—between the acquisition of knowledge and the cultivation of the faculties of the mind. Our knowledge should be as broad as possible, but, in the short space of human life, it is not, as a rule, practicable to cultivate, for effective usefulness, the intellectual powers in more than one direction.

Let me illustrate what I mean from that department of knowledge which is at once the most fundamental and the most essential. I refer to the study of language. No person can be regarded as thoroughly educated who has not the power of speaking and writing his mother-tongue accurately, elegantly, and forcibly; and scholars of the present day must also command, to a considerable extent, both the French

* An address delivered at the opening of the Summer School of Chemistry at Harvard College, July 7, 1884.

and the German languages. These three languages, at least, are the necessary tools of the American scholar, whatever may be the special field of his scholarship, and his end is gained if he has acquired thorough command of these tools. But if he goes further, and studies the philology of these languages, their structure, their derivation, their literature, the study may occupy a lifetime, and be made the basis of severe intellectual training. More frequently, and as most scholars think more effectually, such linguistic training is obtained by the study of the ancient languages, especially the Latin and the Greek, and no one questions the value and efficiency of this form of mental discipline. But obviously such a preparation is not necessary for the use of the modern languages as tools, or in order to acquire a knowledge of ancient history, of the modes of ancient life, or the results of ancient thought. In recent discussions a great deal has been said about the value of classical learning, and it has been argued that no man could be regarded as thoroughly educated who had never heard of Homer or Virgil, of Marathon or Cannæ, of the Acropolis of Athens or the Forum of Rome. Certainly not. But all this knowledge can be acquired without spending six years in learning to read the Latin and Greek authors in the original, or in writing Latin hexameters or Greek iambics. The discipline acquired by this long study is undoubtedly of the highest value, but its value depends upon the intellectual training, which is the essential result, and not upon the knowledge of ancient life and thought, which is merely an incident.

Now, this same distinction, which I have endeavored to illustrate on familiar ground, must not be forgotten in considering the relations of physical science to education. Physical science may also be studied from two wholly different points of view: First, to acquire a knowledge of facts and principles, which are among the most important factors of modern life; secondly, as a means of developing and training some of the most important intellectual faculties of the mind—for example, the powers of observation, of conception, and of inductive reasoning.

The experimental sciences must often be studied chiefly from the first point of view. If no man can be regarded as thoroughly educated who is ignorant of the outlines of Roman and Greek history; one who knows nothing of the principles of the steam-engine, or of the electric telegraph, is certainly equally deficient. I do not question that in most of our high-schools the physical sciences must be taught, for the most part, as funds of useful knowledge, and in regard to such teaching I have only a few remarks to make. Assuming that information is the end to be attained, the best method of securing the desired result is to present the facts in such a way as will interest the scholar, and thus secure the retention of these facts by his memory. I think it a very serious mistake to attempt to teach such subjects by *memoriter* recitations from a text-book, however well prepared. This method at once makes the subject a task; and, if in addition the preparation for an examination is the great end in view, it is wonderful how small is the residuum after the work is done. Such subjects can always be made intensely interesting if presented by lectures, with the requisite illustrations, and I do not believe that the cramming process required to pass an examination adds much to the knowledge previously gained. Many teachers, finding that the parrot-like learning of a text-book is unprofitable, attempt to make the exercise more valuable by means of problems—usually simple arithmetical problems—depending upon principles of physics or chemistry. And there can be no doubt that such problems do serve to enforce the principles they illustrate; but I am afraid they also more frequently, by disgusting the student, stand in the way of the acquisition of the desired knowledge.

It must not be forgotten, in studying the results of science, that the facts are never fully learned unless the learner is made to understand the evidence on which the facts rest. The child who reads in his physical geography that the world revolves on its axis, learns what to him is a mere form of words, until he connects this astronomical fact with his own observation that the sun rises in the east and sets in the west; and so the scholar who reads that water is composed of oxygen and hydrogen has acquired no real knowledge until he has seen the evidence on which this fundamental conclusion rests. Let, then, the sciences be taught as they have been in schools, as important parts of useful knowledge, but let them so be taught as to engage the interest of the scholar, and to direct his attention to the phenomena of Nature.

All this, however, is not scientific culture, in the sense in which I have constantly used the term, and does not afford any special training for the intellectual faculties. For myself, I do not desire any study of natural history, chemistry, or physics from this point of view as a preparation for college; simply because, with the large apparatus of the university, all these subjects can be presented more effectively, and be made more interesting, than is possible in the schools. What I desire to see accomplished by our schools is a training in physical science, comparable in extent and efficiency with that which they now accomplish in the ancient languages. And this brings me to another topic, namely, scientific culture as a system of mental training.

Before attempting to state in what scientific culture consists, we shall do well, even at the expense of some repetition, to show that what often passes for scientific culture is far different from the system of education which we have so constantly advocated. The acquisition of scientific knowledge, however extensive, does not in itself constitute scientific culture, nor is the power of reproducing such knowledge, at a competitive examination, any test of real scientific power. Nevertheless, the examination papers which have been published by the universities of England and of this country show that this is the sole test of scientific scholarship on which most of these universities rely, in awarding their highest honors to students in physical science. The power of so mastering a subject as to be able to reproduce any portion of it with accuracy, completeness, and elegance, at a written examination, is the normal result of literary, not of scientific, culture, and the power is of the same order, whether the subject-matter be philology, literature, art, or science. Indeed, scientific are, as a rule, much less adapted than literary subjects to the cultivation of this power. Moreover, it is also true that scholars, having attained to a very high degree of scholarship, may not possess this power of stating clearly and concisely the knowledge they actually possess. We have all of us known eminent men, possessing in a very high degree the power of investigating Nature, who have been wholly unable to state clearly the knowledge they have themselves discovered. Great harm has been done to the cause of scientific culture by attempting to adapt the well-tried methods of literary scholarship to scientific subjects: for, as I have said in another place, competitive examinations are no test of real attainment in physical science.

Let me not be understood as disparaging the retentive memory and power of concentration which enable the student to reproduce acquired information with accuracy, rapidity, and elegance. This is a power of the very highest order, and is the result of the cultivation to a high degree of many of the noblest faculties of the mind. All I wish to enforce is, that success in such examinations is no indication of scientific culture, properly so called.

What, then, are the tests of true scientific scholarship? The answer can be made perfectly plain and intelligible. The real test is the power to study and interpret natural phenomena. As in classical scholarship the true test of attainment is the power to interpret the delicate shades of meaning expressed by the classical authors, so in science the true test is the power to read and interpret Nature; and this last power, like the other, can as a rule only be acquired by careful and systematic training. As some men have a remarkable facility for acquiring languages, so also there are men who seem to be born investigators of Nature; but by most men such powers can only be acquired through a careful training and exercise of the faculties of the mind, on which success depends. No man would be regarded as a classical scholar, however broad and extended his knowledge, if that knowledge had been acquired solely by reading English translations of the classical authors, however excellent. So, no man can be regarded as a scientific scholar whose knowledge of Nature has been solely derived from books. In either case the real scholar must have been to the fountain-head and drawn his knowledge from the original sources. In order, then, to discover how scientific culture must be gained, we must consider the conditions on which the successful study and interpretation of Nature depend.

Of the powers of the mind called into exercise in the investigation of Nature, the most obvious and fundamental is the power of observation. By power of observation is not meant simply the ability to see, to hear, to taste, or to smell with delicacy, but the power of so concentrating the attention on what we observe as to form a definite and lasting impression on the mind. There are undoubtedly great differences among men in the acuteness of their sensations, but successful observation depends far less upon the acuteness of the senses than on the faculty of the mind which clearly distinguishes and remembers what is seen and heard. We say of a man that he walks through the world with his eyes shut, meaning that, although the objects around him produce their normal impression on the retina of his eye, he pays no attention to what he sees. The power of the naturalist to distinguish slight differences of form or feature in natural objects is simply the result of a habit, acquired through long experience, of paying attention to what he sees, and the want of this power in students who have been trained solely by literary studies is most marked.

An assistant who was at the time conducting a class in mineralogy, once said to me: "What am I to do? One of my class can not see the difference between this piece of blend and this piece of quartz" (showing me two specimens which bore a certain superficial resemblance in color and general aspect). My answer was, "Let him look until he can see the difference." And, after a while, he did see the difference. The difficulty was not lack of vision, but want of attention.

The power of observation, then, is simply the power of fixing the attention upon our sensations, and this power of fixing the attention is the one essential condition of scholarship in all departments of learning. It is a power which ought to be cultivated at an early age, and in a system of scientific culture the sciences of mineralogy and botany afford the best field for its culture, and I should therefore place them among the earliest studies of a scientific course. Minerals and plants may be profitably studied in the youngest classes of our secondary schools, but they should be studied solely from specimens, which the scholar should examine until he can distinguish all the characteristics of form, feature, or structure. I am told that in many of our secondary schools both mineralogy and botany are studied with great success and interest in the manner I have indicated. But a mistake is frequently made in attempting to do too much. With mineralogy or botany as classificatory sciences, our secondary schools should have nothing to do. The distinction between many, even of the commonest, species of minerals or plants depends upon delicate distinctions which are quite beyond the grasp of young minds, and the study of botany frequently loses all its value, through the ambition of the teacher to embrace so much of systematic botany as will enable scholars "to analyze plants."

If a child, twelve or fourteen years of age, is made to observe the characteristic qualities of a few common minerals so as to enable it to recognize them in the rocks, and is likewise led to examine the structure of a few familiar flowers, not only will a new power have been acquired, but a new interest will have been added to life.

Of course, the faculty of observation thus early exercised in childhood only attains the highest degree of development after long experience and continued practice. The acuteness which practice gives is frequently very remarkable, and rude men often surprise us by the extent to which their power of observation has been cultivated in certain special directions. The sailor who recognizes the outlines of to him a well-known coast, where the ordinary traveler sees nothing but a bank of clouds, or the miner who recognizes in the rock indications of valuable ores, are illustrations which may give a clearer conception of the nature of the power we have been attempting to describe.

Naturally following the power of observation in the order of education is the power of conception with the cognate power of abstraction ; that is, the power of forming in the mind distinct and accurate images of objects, and relations, which have been previously apprehended either by direct observation, or through description ; and also the power of confining the attention to certain features which these images may present to the exclusion of all others. This is a power which depends very greatly on the imagination and is capable of being cultivated to a very high degree. There is no study which is so well suited to the training both of the powers of conception and of abstraction as the study of geometry.

To this end the study of geometry should be begun at an early period in school-life, and it should be studied at first not as a series of propositions logically connected, but as a description of the properties and relations of lines, surfaces, and solids—what has sometimes been called "the science of form." A text-book prepared on this idea by Mr. G. A. Hill forms an admirable introduction to the study.

I esteem very highly the system of geometry of Euclid, either in its original form or as it has been modified by modern writers, as a means of developing the logical faculty. The completeness of the proof of the successive propositions and their mutual dependence by means of which, as on a series of steps, we mount from simple axiomatic truths to the most complex relations, furnish an admirable discipline for the reasoning power ; but too often the whole value of this discipline is lost by the failure of the pupil to form a clear conception of the very relations about which he is reasoning, and the study becomes an exercise of the memory and nothing more. Often have I seen a conscientious and faithful student draw an excellent figure, and write out an accurate demonstration, without noticing that the two were not mated; and in a recent meeting of teachers of our best secondary schools it was gravely asserted that solid geometry was the most difficult study with which the teachers had to deal. In solid geometry, however, the reasoning is no more difficult than in plane geometry, but the conceptions are far more complex, and, if the teacher insisted that the pupil should not take a single step until his conceptions were perfectly clear, all the difficulties would disappear. Of this I am fully persuaded, for I have had to encounter the same difficulties over and over again in teaching crystallography. In beginning the study of geometry, of course the power of conception should be helped in every possible way. Let your pupil find out by actual measurement that the sum of the angles of a triangle is equal to two right angles, and he will easily discover the proof of the proposition himself. So also, if he actually divides with his knife a triangular prism made from a potato or an apple into three triangular pyramids, he will find no difficulty in following the reasoning on which the measurement of the solid contents of a sphere depends. Let me assure teachers that the study of geometry, taught as I have indicated, is a most valuable introduction to the study of science. But, as it has been usually taught as a preparation for college, it is almost worthless in this respect, however valuable it may be as a logical training.

I consider practice in free-hand drawing from natural objects a most valuable means of training both the power of observation and the power of conception, besides giving a skill in delineation which is of the greatest importance to the scientific student. Accuracy of drawing requires accuracy in observation, and also the ability to seize upon those features of the object which are the most prominent and characteristic. Hence, in a course of scientific training, the importance of practice in drawing can hardly be exaggerated, and it should be made one of the most important objects of school-work from an early period.

To the scientific student the powers of observation and conception are not sought as ends in themselves, but as means of studying Nature. The precise portions of this wide field to which the attention of the student shall be directed will be determined by many circumstances, and it is not our purpose in this address to lay down a plan of study. To most students the natural history subjects offer the most attractive field; but all, I think will admit, that the experimental sciences should form a considerable portion, at least, of the course of all scientific students, whatever specialty may subsequently be chosen. That on which I desire particularly to dwell is the spirit in which all these studies should be pursued; and I can best illustrate what I mean by confining my remarks to that subject in which I am most interested, and in regard to which I have the greatest experience.

In a course of scientific study, chemistry can not be dissociated from physics, and the two sciences ought to be studied to a great extent in connection with each other. Not only does the philosophy of chemistry rest upon physical conceptions; but, moreover, chemical methods involve physical principles. There is, however, a distinction to be made; for, while some of the departments of physics are best studied as a preparation for chemistry, there are other subjects which are best deferred until the student has some knowledge of chemical facts. Among the preliminary subjects we should mention elementary mechanics, including hydrostatics and pneumatics, and also thermotics; while electricity, acoustics, and optics, including the large subject of radiant energy, may well be deferred until after the study of chemistry.

In the study both of chemistry and physics there are of course two definite objects to be kept in view: In the first place, a knowledge of the facts of the science is to be acquired; in the second place, the student must learn by experience how these facts have been discovered. It would be obvious, from a moment's reflection, that a knowledge of the circumstances under which the facts of Nature are revealed to the student is essential to a complete apprehension of the facts themselves. The child who is taught that the earth moves in an elliptical orbit around the sun in one year does not in the least grasp the wonderful fact thus stated, and will not come to realize it until he connects the statement with the nightly precession of the stars in the heavens. And it is just such a connection as this which the teacher must seek to establish in all scientific teaching. In experimental science such a connection is most readily established in the mind of the student by means of a series of well-arranged experiments, which each one repeats for himself at the laboratory table. Obviously, however, it is impossible, in a limited course of teaching, to go over the whole ground of chemistry or physics in this way, or even over that small portion of the ground with which the average scientific student can expect to become acquainted. Nor is this necessary; for, after one has realized the connection between phenomena and conclusion in a number of instances, the mind will fully comprehend that a similar connection exists in other cases, and will understand the limitations with which scientific conclusions are to be received.

Hence, it seems to me that, in teaching chemistry or physics, it is best to combine a course of lectures which should give a broad view of the whole ground with a course of laboratory instruction, which must necessarily be more or less restricted. Experimental lectures are, I am convinced, much the best way of presenting these subjects as systematic portions of knowledge. It is not necessary that the lectures should be formal, but it is all-important that they should be given in such a way that the interest of the student should be awakened, and that they should be fully illustrated by specimens and experiments. What we read in a book does not make one half the impression that is produced by the words of a living teacher, nor can we realize the facts unless we see the phenomena described. There is undoubtedly, however, an advantage to be gained in subsequently reviewing the subject as presented in a good text-book, and such a book may be of great use in preparation for an examination. But how far examinations are of value in enforcing the acquisition of knowledge of an experimental science is a question on which I feel a grave doubt. Certainly their value is very small if, as is too frequently the case, they lead the student to defer all effort to make his own the knowledge presented in the lectures, until a final cram.

The management of lectures, text-books, and examinations, will not, however, offer nearly so great difficulties to the teacher as the management of the parallel experimental course of laboratory teaching. In the last the methods are less well tried and demand of the teacher a very considerable amount of invention and experimental skill. To follow mechanically any text-book would result in a loss of the proper spirit with which the course should be conducted and which constitutes its chief value. No experiments are so good as those which have been devised by the teacher, or, still better, by the pupils themselves. A mere repetition of a process, according to a definite description, has no more value than a repetition of a form of words in an ordinary school recitation. The teacher must make sure that the student fully understands what he is about, and comprehends all the connections between observations and conclusions which it is his aim to establish. Moreover, he must constantly encourage his students to think and work for themselves, and direct them in the methods of inductive reasoning. The failure of an experiment may be made most instructive if the student is led to discover the cause of the failure. A leak in his apparatus may be turned to a similar profit if the student is shown how to discover the leak, by carefully eliminating one part after another until the weak point is made evident.

The direction of an experimental laboratory is no easy task. The teacher must make each man's work his own, and follow his processes of thought as well as his experiments with the most careful attention. With large classes much time can be saved by going through each process on the lecture-room table and giving the directions to the class as a whole ; but this does not supersede the personal attention and instruction which each student requires at the laboratory table. Moreover, in laboratory teaching the teacher must rely, as we have said, on his own resources, and but few aids can be given. There are books, however, which will help the teacher to prepare himself for his work, and I am happy to say that a book entitled "The New Physics," prepared by my colleague, Professor Trowbridge, is now being printed, which I hope will greatly promote the laboratory teaching of physics. Nicholl's abridgment of Eliot and Storer's "Manual" has long served a similar valuable purpose in chemistry, and there are many excellent works on "Qualitative Analysis," a study which is admirably adapted to develop the power of inductive reasoning.

There is, however, a danger with all laboratory manuals, which must be sedulously avoided, and the danger is generally greater the more precise the descriptions. They are apt to induce mechanical habits which are fatal to the true spirit of laboratory teaching. Not long ago I asked a student, who was working in our elementary laboratory, what he was doing. He answered that he was doing No. 24, and immediately went for his book to see what No. 24 was. I fear that a great deal of laboratory work is done in a way which this anecdote illustrates, and, if so, it is a mere waste of time.

When teaching qualitative analysis it was always with me a constant struggle to prevent just such a result, and many of the excellent tables which have been prepared to facilitate analysis simply encourage the evil practice. It is an error to which college students, with their exclusively literary preparation, are especially liable, and I have no question that the proper conduct of our laboratories would be made much easier if the students came with a previous scientific training.

Thus far I have dealt solely with generalities, and my object has been not so much to give definite directions as to make suggestions which might lead to better systems of teaching. The details of these systems may vary widely, and yet all may lead to the desired result if only the true spirit of scientific teaching is preserved, and a teacher's own system is generally the best system for him. This leads me to explain my own system of teaching chemistry—which presents some novelties that may be of interest, and, although it has been worked out in detail in the revised edition of the "New Chemistry," just published, still a few words of explanation may be of value at this time in setting forth its salient points.

Chemistry has been usually defined as the science which treats of the composition of bodies, and in most text-books the aim has been to develop the scheme of the chemical elements, and to show that, by combining these elements, all natural and artificial substances may be prepared. In the larger text-books, which aim to cover the whole ground and to describe all known substances, such a method is both natural and necessary. But, as an educational system, this mode of presenting the subject is, as a rule, profitless and uninteresting. The student becomes lost amid details which he can only very imperfectly grasp, and the great principles of the science, as well as their relations to cognate departments of knowledge, are lost sight of. Moreover, the system is unphilosophical, because it presents the conclusions of chemistry before the observations on which they are based. Any one who has attempted to teach chemistry from the ordinary elementary text-books must have experienced the truth of what I have said.

A student learns a lesson about sodium and the various salts of this metal, and, after glibly reciting the words of the text-book, how much more does he know of the real relations of these bodies than he did before? Thus. Chloride of sodium symbol, NaCl. Crystallizes in cubes. Soluble in water. Solubility only slightly increased by heat. Generally obtained by evaporation of sea-water in pans. Also found in beds in certain geological basins from which it is extracted by mining. When acted upon by sulphuric acid, hydrochloric acid is evolved and sodic sulphate is formed, according to the following reaction, and so on. I have known a student to recite all this and a great deal more, without ever dreaming that he had been eating chloride of sodium on his food, three times a day at least, since he was born.

Now, the rational system of teaching chemistry is first to present to the scholar's mind the phenomena of Nature with which the science deals. Lead him to observe these phenomena for himself; then show him how the conclusions which together constitute that system of knowledge we call chemistry have been deduced from these fundamental facts. My plan is to develop this system in the lecture-room in as much detail as the time allotted will permit; to illustrate all the points by experiment, and in addition to explain more in detail carefully selected fundamental experiments, which the student subsequently repeats in the laboratory himself. Thus I make the lecture-room instruction and the laboratory demonstration go hand in hand as complementary parts of a single course of teaching.

To begin with the subject-matter of chemistry. In the broad fields of Nature what portion does this science cover? Natural phenomena may obviously be divided into two great classes: First, those changes which do not involve a transformation of substance; and, secondly, those changes whose very essence consists in the change of one or more substances into other substances having distinctive properties. The science of physics deals with the phenomena of the first class; the science of chemistry with those of the last. Any phenomenon of Nature which involves a change of substance is a chemical change, and in every chemical change one or more substances, called the factors, are converted into another substance or into other substances called the products. The first point to be made in teaching chemistry is, that a student should realize this statement, and a number of experiments should be shown in the lecture-room and repeated in the laboratory illustrating what is meant by a chemical change.

Here, of course, arises a difficulty in finding examples which shall be at once simple and conclusive, for in almost all natural phenomena there is a certain indefiniteness which obscures the simple process. The familiar phenomena of combustion are most striking examples of this fact, and men were not able to penetrate the mist which obscured them until within a hundred years. To find chemical processes whose course is obvious to an unpracticed observer, we are obliged to resort to unfamiliar phenomena.

A very simple example of a chemical process is a mixture of sulphur and zinc in atomic proportions, which, when lighted with a match, is rapidly converted into white sulphide of zinc, with appearance of flame. Another example, a mixture of sulphur and fine iron-filings, which, when moistened with a little water, rapidly changes into a black sulphide of iron. Then some copper filings, which, when heated on a saucer in the open air, slowly change into black oxide of copper. Then a bit of phosphorus, burned in dry air under a glass bell, yielding a white oxide. Next, some zinc, dissolved in diluted sulphuric acid, yielding hydrogen gas and sulphate of zinc. Then, a solution of chloride of barium added to a solution of sulphate of soda, giving a precipitate of sulphate of baryta, and leaving in solution common salt, which can be recovered by evaporating the filtrate.

In all these examples the student should be made to see and handle all the factors and all the products of each process, and the experiments should be selected so that he may become familiar with the different conditions under which substances appear, and with various kinds of chemical processes. He should also be made clearly to distinguish between the essential features of the process and the different accessories, which may be more or less accidental—such, for example, as the water used in determining the combination of iron and sulphur, or the flame which accompanies combustion.

After a clear conception has been gained of a chemical process, with its definite factors and definite products, we are prepared for the next important step. Every chemical process obeys three fundamental laws:

The Law of Conservation of Mass.
The Law of Definite Proportions.
The Law of Definite Volumes.

According to the first law, the sum of the weights of the products of a chemical process is always equal to the sum of the weights of the factors. This law must now be illustrated by experiments, and approximate quantitative determinations should be introduced thus early into the course of study. All that is required for this purpose is a common pair of scales, capable of weighing two or three hundred grammes, and turning with a decigramme. We use in our laboratory some platform-scales, made by the Fairbanks Company, which are inexpensive, and serve a very useful purpose.

A very satisfactory illustration of the law of conservation of mass can be obtained by inserting in a glass flask a mixture of copper filings and sulphur in atomic proportions. The glass flask is first balanced in the scale-pan; then removed and gently heated until the ignition which spreads through the mass shows that chemical combination has taken place. The flask is lastly allowed to cool, and on reweighing is found not to have altered in weight.

For a second experiment, a bit of phosphorus may, with the aid of some simple contrivance, be burned inside a tightly corked glass flask, of sufficient volume to afford the requisite supply of oxygen. Of course, on reweighing the flask, after the chemical change has taken place, and the bottom of the flask covered with the white oxide formed, there will be no change of weight, and this experiment may be made to enforce the truth that, in this example of combustion at least, the chemical process is attended with no loss of material. Open now the flask, and air will rush in to supply the partial vacuum, proving that in the process of combustion a portion of the material of the air has united to form the white product.

Make now a third experiment as an application of the general principle which has been illustrated by the previous experiments. Burn some finely divided iron (iron reduced by hydrogen) on a scale-pan, and show that the process is attended by an increase of weight. What does this mean? Why, that some material has united with the iron to form the new product. Whence has this material come? Obviously from the air, for it could come from nowhere else. And thus, besides illustrating the first of the above laws, this experiment may be made to furnish an instructive lesson in regard to the relations of the oxygen of the atmosphere to chemical processes.

The second law declares that in every chemical process the weights of the several factors and products bear a definite proportion to each other. This law must next be made familiar by experimental illustrations. A weighed amount of oxide of silver is placed in a glass tube connected with a pneumatic trough. The tube is gently heated until the oxide is decomposed and the oxygen gas collected in a glass bottle of sufficient size. The metallic silver remaining in the tube is now reweighed, and the volume of the oxygen gas in the bottle measured, and from the volume of the gas its weight is deduced. The measurement is easily made by simply marking with a gummed label the level at which the water stands in the bottle. If, now, the bottle is removed from the pneumatic trough and the weight of water found which fills the bottle to the same height, the weight of the water in grammes will give the volume of the gas in cubic centimetres, and, knowing the weight of a cubic centimetre of oxygen, we easily calculate the weight of this gas resulting from the chemical process. We have now the weights of the oxide of silver, the silver, and the oxygen, the one factor and the two products of the chemical process, and, by comparing the results of different students making the same experiment, the constancy of the proportion will be made evident to the class.

For a second illustration of the same law, the solution of zinc in dilute sulphuric acid, yielding sulphate of zinc and hydrogen gas, may be selected, and the weight of the hydrogen, estimated as in the previous example, shown to sustain a definite relation to the weight of the zinc dissolved.

Again, silver may be dissolved in nitric acid, and the weight of the nitrate of silver obtained shown to sustain a definite relation to the weight of the metal.

Or, still further, as an experiment of a wholly different class, a known weight of chloride of barium may be dissolved in water, and, after precipitation with sulphuric acid, the baric sulphate collected by filtration and weighed, when the definite relation between the weight of the precipitate and the weight of the chloride of barium will appear.

For a last experiment let the student neutralize a weighed amount of dilute hydrochloric acid with aqua ammonia, noting approximately the amount of ammonia required. Let him now evaporate the solution on a water-bath, and weigh the resulting saline product; taking next the same quantity of hydrochloric acid as before, and, having added twice the previous quantity of ammonia, let him obtain and weigh the resulting sal-ammoniac as before. A third time let him begin with half the quantity of hydrochloric acid, and, adding as much ammonia as in the first case, again repeat the process. It is obvious what the result of these experiments must be, but, without telling the student what he is to expect, it will be a good exercise to ask him to draw his own inferences from the results. Of course, he must previously have so far been made acquainted with the properties of hydrochloric acid and ammonia as to know that the excess of either would escape when the saline solution was evaporated over a water-bath. But with this limited knowledge he will be able to deduce the law of definite proportions from the experimental results thus simply obtained.

The third of the fundamental laws of chemistry stated above (generally known as the law of Gay-Lussac) declares that, when two or more of the factors or products of a chemical process are aëriform, the volumes of these gaseous substances bear to each other a very simple ratio. Here, again, numerous experiments may be contrived to illustrate the law. Water, when decomposed by electricity, yields hydrogen and oxygen gases whose volumes bear to each other the ratio of two to one. When hydrochloric-acid gas is decomposed by sodium amalgam, the volume of the original gas bears to that of the residual hydrogen the ratio also of two to one. When ammonia is decomposed by chlorine, the volume of the resulting nitrogen gas is one third of that of the chlorine gas employed.

Having illustrated these three general laws, attention should be directed to the fact that the nature of a chemical process and the laws which it obeys are results of observation and involve no theory whatsoever. On these facts the science of chemistry is built. The modern system of chemistry, however, assumes what is known as the molecular theory, and by means of this theory attempts to explain all these facts and show their relation to each other. Here the distinction between fact and theory must be insisted upon, and also the value of theory for classifying facts and directing observation.

A molecule is now defined, and, if the student has not studied physics sufficiently to become acquainted with the outlines of the kinetic theory of gases, this theory must be developed sufficiently to give the student a knowledge of the three great laws of Mariotte, of Charles, and of Avogadro. He must be made to understand how molecules are defined by the physicist, and how their relative weights may be inferred by a comparison of vapor densities. He should then be made to compare the relative molecular weights, deduced by physical means, with the definite proportions he has observed in chemical processes. He will thus himself be led to the conclusion that these definite proportions are the proportions of the molecular weights, and that the constancy of the law arises from the fact that in every chemical process the action takes place between molecules, and that the products of the process are new molecules, preserving always, of course, their definite relative weights. The student will thus be brought to the chemical conception of the molecule as the smallest mass of any substance in which the qualities inhere, and he will come to regard a chemical process as always taking place between molecules.

Thus far nothing has been said about the composition of matter. A chemical process has been defined simply as certain factors yielding certain products, but nothing has been determined about the relations of these several substances except in so far as they are defined by the three laws illustrated above. But now it must be shown that a study of different chemical processes compels us to conclude that in some cases two or more substances unite to form a compound, while in other cases a compound is broken up into simpler parts. Thus, when copper filings are heated in the air, it is evident that the material of the copper has united with that portion of the air we call oxygen to form the black product we call oxide of copper; and again, when oxide of silver is heated, it is evident that the resulting silver and oxygen gas were formerly portions of the material of the oxide. So, when water is decomposed by electricity, the conditions of the experiment show that the resulting oxygen and hydrogen gases must have come from the material of the water, and could have come from nothing else.

Experiments should now be multiplied until the student has a perfectly clear idea of the nature of the evidence on which our knowledge of the composition of bodies depends. The decomposition of chlorate of potash by heat, yielding chloride of potassium and oxygen gas; the decomposition of nitrate of ammonium by heat, yielding nitrous oxide and water; the decomposition of this resulting nitrous oxide, when the gas is passed over heated metallic copper; and, lastly, the decomposition already referred to, of water by electricity, are all striking experiments by which the evidence of chemical composition may be enforced.

The distinction between elementary and compound substances having been clearly defined by the course of reasoning already given in outline, the next aim should be to lead the student to comprehend how substances are analyzed and their composition expressed in percents. The reduction of oxide of copper by hydrogen gives readily the data for determining the composition of water, which is thus shown to contain in one hundred parts 11·11 per cent of hydrogen and 88·89 per cent of oxygen.

Another substance whose analysis can be very readily made by the student is carbonate of magnesia. By igniting pure carbonate of magnesia in a crucible (not of course the "magnesia alba" of the shops), the proportions of carbonic acid and magnesia can be readily determined. Then, by burning magnesium ribbon, and weighing the product, the student easily finds the relative weight of magnesium and oxygen in the oxide. And, lastly, the proportion of carbon and oxygen in carbonic dioxide is easily deduced from the burning of a weighed amount of carbon. Here the result may be expressed either in percents of oxide of magnesium and carbonic dioxide, or else in percents of the elementary substances, carbon, magnesium, and oxygen.

After making a few analyses like these, the student will be prepared to comprehend the actual position of the science. All known substances have been analyzed, and the results tabulated, so that it is unnecessary to repeat the work except in special cases.

The teacher is now prepared to take a very important step in the development of the subject. If the molecule is simply a small particle of a substance in which the qualities of the substance inhere, then it follows, of course, that the composition of the molecule is the same as the composition of the substance. The percentage results of the analysis of water, or of carbonate of magnesia, indicate the composition of a molecule of water or a molecule of carbonate of magnesia. Thus, 11·11 per cent of every molecule of water consists of hydrogen, while 88·89 per cent consists of oxygen. Hence it follows that, in a chemical process, the molecules must be divided, and these elementary parts of molecules which analysis reveals are the atoms of chemistry. Moreover, as we know the weights of the molecules, both by physical and chemical means, chemical analysis now gives us the weights of the atoms. We have no time to dwell on the details of this reasoning, but the general course to be followed will be evident, and it must be enforced by numerous examples.

Assuming that the student fully comprehends the distinction between molecules and atoms—that is, between the physically smallest particles and the chemically smallest particles—he is prepared to master the symbolical nomenclature of chemistry, with a very few words of explanation. The initial letters of the Latin names are selected to represent the atoms of the seventy known elementary substances, and these letters stand for the definite atomic weights which are tabulated in all chemical text-books. The symbols of the atoms are simply grouped together to form the symbols of the molecules of the various substances; the number of atoms of each kind entering into the composition of the molecule being indicated by a subscript numeral. Lastly, in order to represent chemical processes, the symbols of the molecules of the factors are written on one side and the symbols of the molecules of the products are written on the other side of an equation, the number of molecules of each substance involved being indicated by numerical coefficients.

The atomic symbols, as we have seen, stand for definite weights. In the same way, the molecular symbols stand for definite weights, which are the sums of the weights of the atoms of which each consists, and in every chemical equation the weights of the molecules represented on one side must necessarily equal the weights of the molecules represented on the other. The chemical process consists merely in the breaking up of certain molecules, and the rearrangement of the same constituent atoms to form new molecules. Again, as the molecular symbols represent definite weights, the equation also indicates that a definite proportion by weight is preserved between the several factors and products of the process represented.

Again, since every molecular symbol represents the same volume when the substance is in an aëriform condition, it follows that the relative gas volumes are proportional to the number of molecules of the aëriform substances involved in the reaction. Thus it is that these chemical equations or reactions are a constant declaration of the three great fundamental laws of chemistry.

In order to enforce the above principles, a great number of examples should now be given which should be so selected as to illustrate familiar and important chemical processes, including the all-important phenomena of combustion. In each case, the student, having made the experiment, should write the equation or reaction which represents the process, and should be made to solve a sufficient number of stochio-metrical problems, involving both weights and volumes, to give him a complete mastery of the subject. Such questions as these will test the completeness of his knowledge:

Why is the symbol of water H_2O? What information does the symbol CO_2 give in regard to carbonic-dioxide gas? Write the reaction of hydrochloric acid on sodic carbonate, and state what information the equation gives in regard to the process which it represents.

Of course, such questions may be greatly multiplied, and I cite these three only to call attention to the features of the method of instruction I have been endeavoring to illustrate.

But, besides teaching the general principles of chemical science, it is important to give the student a more or less extended knowledge of chemical facts and processes—especially such as play an important part in daily life, or in the arts—and such knowledge can readily be given in this connection. Beyond this I do not deem it desirable to go in an elementary course of instruction. The way, however, is now opened to the most advanced fields of the science. A comparison of symbols and reactions leads at once to the doctrine of quantivalence, and to the results of modern structural chemistry, which this doctrine involves. Among these results there is of course much that is fanciful, but there is also a very large substratum of established truth ; and if the student thoroughly comprehends the symbolical language of chemistry, and understands the facts it actually represents, he will be able to realize, so far as is now possible, the truths which underlie the conventional forms.

The study of the structure of molecules naturally leads to the study of their stability, and of the conditions which determine chemical changes, and thus opens the recently explored field of thermochemistry. To be able to predict the order and results of possible conditions of association of materials, or of chemical changes under all circumstances, is now the highest aim of our science, and we have already made very considerable progress toward this end. But I have detained you too long, and I must refer to the "New Chemistry" for a fuller exposition of this subject. My object has been gained if I have been able to make clear to you that it is possible to present the science of chemistry as a systematic body of truths independent of the mass of details with which the science is usually encumbered, and make the study a most valuable means of training the power of inductive reasoning, and thus securing the great end of scientific culture.

THE UPPER MISSOURI RIVER SYSTEM.

By LESTER F. WARD, A. M.

THE Missouri River, as is well known, is the larger of the two great branches which unite to form the Lower Mississippi, discharging at its mouth 120,000 cubic feet of water per second, while the Upper Mississippi discharges only 105,000 cubic feet per second. It is therefore itself properly the Upper Mississippi. The perpetually turbid character of its waters is a familiar fact to the ordinary reader, even if he has never seen them.

It is proposed to state a few facts, derived from a season's personal observation in the valley of the Upper Missouri and of its nearly equal tributary, the Yellowstone, which may account for this condition, and serve to explain the peculiar form of erosion that characterizes this river system.

The upper portion of these rivers, where they flow through mountain-gorges, form deep cañons, and leap over wild cascades, is, of course, more interesting than their lower portions, where the flow, though rapid, is tolerably uniform through valleys of considerable width and among low sand-bars and islands of their own creation. As a consequence of this, we find that it is this upper portion that has received the chief attention by writers and explorers, who hasten through the duller parts of the country and make only a meager record of them. Another reason for this has been that it is in the region of country about the sources of these rivers that the most profitable mining and agricultural enterprises have been conducted, and large and thriving settlements, even cities, have grown up there, unaided by railroad connections, and communicating with the civilized world by overland routes—not along the river-valley, but across the country from the south, uniting this region with the Salt Lake Basin. It is thus that Helena, Bozeman, Virginia City, and, to a large extent, Fort Benton, now a thriving town, have come into existence, cut off, as it were, on the east, with the great valleys through which the waters of this region are led back to the inhabited parts of the country in a condition akin to unexplored. This was especially the case with the Yellowstone Valley prior to the construction of the Northern Pacific Railroad.

The Yellowstone, from its rapid current of about three miles per hour, its frequent sand-bars, shoals, rapids, and other obstructions, is scarcely navigable at all ; while the Upper Missouri, though navigable with great difficulty in high water as far as Fort Benton, or even to its Great Falls, forty miles above that point, possesses a sad history of wrecks, disasters, and failures.

The Yellowstone and Upper Missouri Rivers flow in an easterly direction, nearly parallel to each other and at a distance of about one hundred miles apart, at least for the lower half of their course. Above the Musselshell, which stretches nearly across the intervening space, the country is more or less mountainous, the fall of the water is more rapid, the bottom usually gravelly or rocky, the valleys narrow, and the water clear except in times of flood. Below the Musselshell of the Missouri and the Big Horn of the Yellowstone, nearly opposite, this Mesopotamian region consists of an elevated plain wholly destitude of arborescent vegetation. Its elevation, though not sufficient to be called mountainous, is considerable, and is formed by several distinct rises or terraces. The summit is a level plain, and contains large lakes or marshes in which wild-geese and other water-fowls in immense numbers breed and rear their young. From this plateau long valleys, sometimes of considerable width, descend to the rivers, carrying streams of water which, in some cases, persist throughout the year. The highest part, or divide proper, between the rivers is not central but is nearer the Missouri, which has rugged banks on its south side, with some of the features of the Dakota Bad Lands. Toward the Yellowstone the slope is gradual, and the terraces become lower and lower until the river-valley proper is reached. The right bank of the Yellowstone for most of this distance is similar to the right bank of the Missouri, and toward its mouth the country lying south of the river is not to be distinguished from the true Bad Lands of the Little Missouri adjacent to it. On the other hand, whatever wide flats or

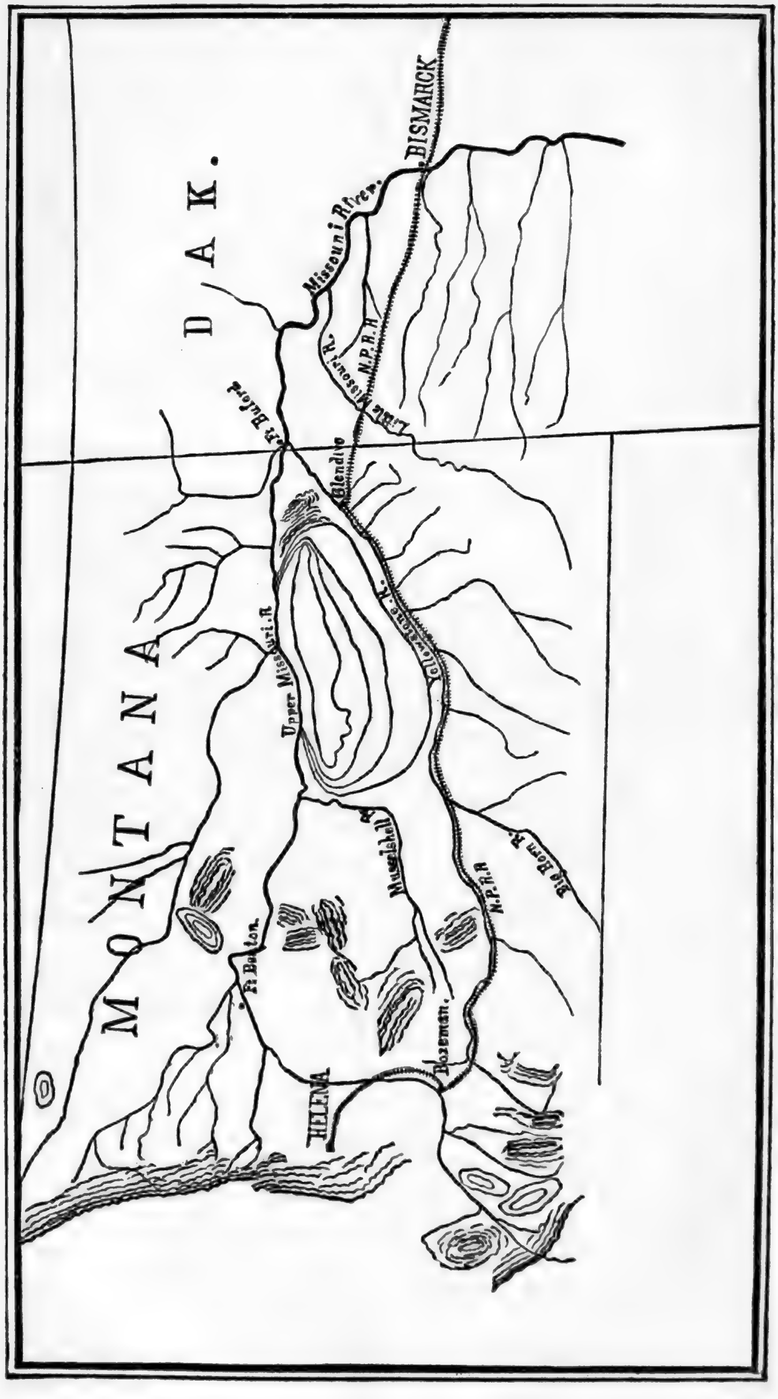

Diagram No. I.—Upper Missouri River System.

low country the Missouri here possesses are generally to be found on the north or left bank of that river (see Diagram No. I).

Without attempting a description of those strange and interesting *mauvaises terres*, which are the favorite theme of popular writers, I shall endeavor to give some idea of the process by which the valleys of these rivers have been formed and of the action of the rivers within their present bed. It is quite evident that the entire configuration of the land-surface of the region has been the result of erosion, and distinct breaks or even low cliffs sometimes occur, showing the edges of the horizontal strata. At intervals of from five to ten miles small streams or creeks fall into the river, often entirely dry in summer, sometimes containing a small quantity of perfectly transparent water, but so charged with alkali as to whiten the pebbles over which it flows, and to render its use by man or beast almost impossible. These creeks, locally denominated *coulées*—a name given them by the early French explorers—have excavated valleys of different lengths and widths, and between these occur narrow plains, or even mere ridges. Of the immense volume of solid earth and rock that has been brought down by the process of eroding these terraces, creek-valleys, etc., only a minute fraction has been retained, but this has been deposited near the river, forming an alluvial bottom of varying width. This alluvial deposit it is the function of the river perpetually to wear away, while at the same time laying down new matter, with which it is constantly charged, to take its place. The result is, that throughout the lower portions of these rivers, and also in the Missouri Valley below their junction, the bed of the river is perpetually shifting its position in the general valley. When we contemplate the entire history of the river, the valley must be regarded as due to this process, and its great width relatively to that of the stream itself can only thus be accounted for. But, if we contemplate it only at a given time, as the present, the valley appears to consist of two quite distinct parts, viz., the river-bed and the valley proper, raised above it and gradually sloping back on one or both sides to the foot of the first terrace. If, in time of low water, we compare these two parts, the latter will appear to be stable, while the former will clearly show that it is unstable. There was probably never a time in the river's history when these two distinct features did not exist much as now, though no one can say how many times the river may have worn away the stable portion of its valley on one side while it was forming anew on the other, and afterward receded and carried off the last-formed valley, leaving its previous bed to be again filled up until it has regained all the aspect of permanence which it previously possessed. This crossing and recrossing by the river-bed of the general valley, proceeding simultaneously with the work of lateral erosion, have gradually lowered the valley to its present position and are still lowering it. In a certain sense this applies to all rivers and river-valleys, but nowhere perhaps

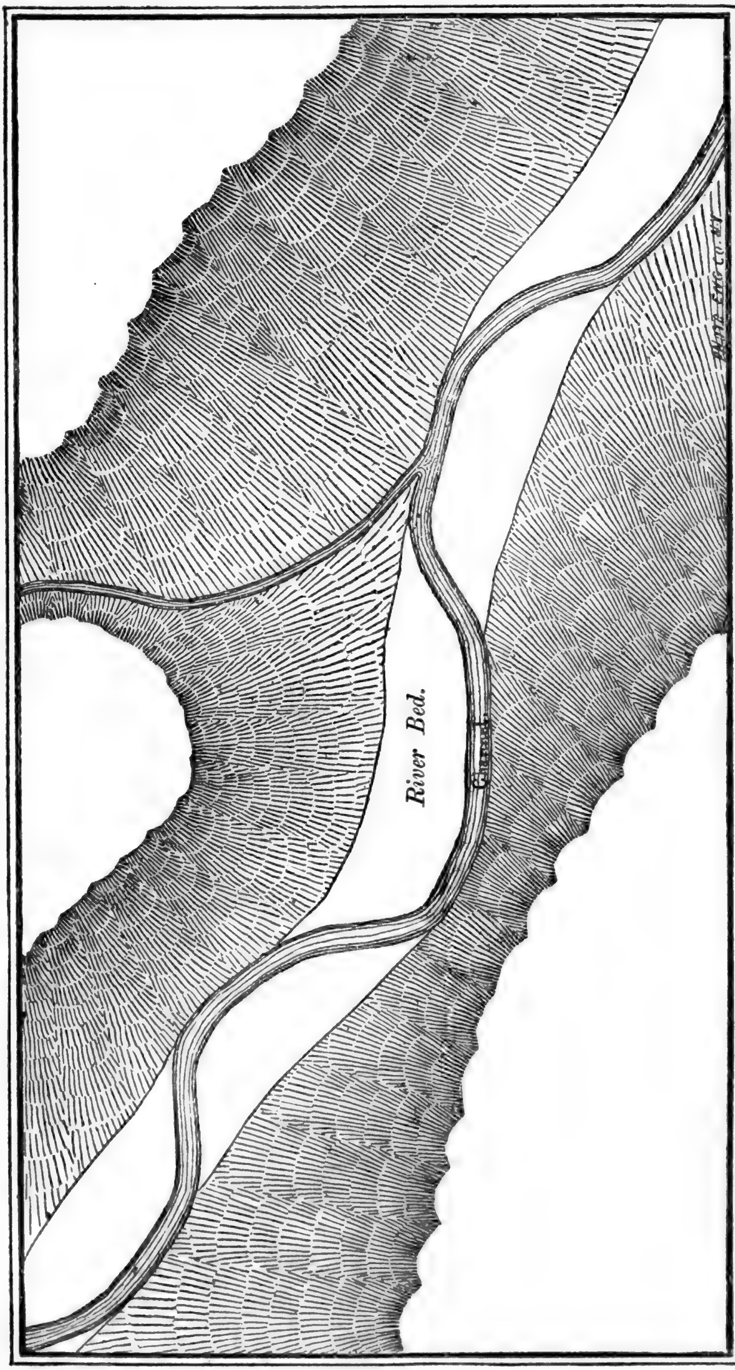

Diagram No. II.—Plan of River Valley.

on the globe does there exist a better example from which to study these principles of surface erosion than in the Upper Missouri River system. This will be best seen when we consider a little more closely the proper bed of the river.

For two or three months of each year, between March and June, the river is high, and this state of high water is tolerably uniform from year to year, so as to be in a manner normal. Supplied chiefly from melting snows at greater and greater altitudes as the season advances, it persists with only slight fluctuations until the supply is exhausted, when the water slowly falls to its low-water mark, where it remains the rest of the year with only a small amount of variation, because the rainfall is so light. There thus exist two distinct and somewhat uniform conditions of the water, each occupying its regular part of the year. Owing to this regularity of high water, the maximum bed of the river produced by it is somewhat uniform and clearly marked, while it also bears a tolerably uniform relation to the deeper channel represented by the low-water state. Examined in time of low water, this river-bed seems to be three or four times as wide as the river itself. The stream, then, usually flows in serpentine curves which cross and recross the bed. The bed itself is also crooked much as is the channel, only its curves are as much longer as it is wider. The whole valley is usually also winding with much more ample curves, and the river-bed crosses and recrosses it in a manner similar to that in which the channel crosses and recrosses the bed. The river itself generally hugs one of the banks of the bed, but it is always at a curve, or bend, such as will tend to wear the bed on the convex side and thus render it more crooked. The distance traversed by the channel in crossing from one side of the bed to the other is small, compared with the distance traversed while in close contact with the bank of the river-bed, which it is perpetually extending into the general valley. The reason why it does not constantly grow wider is, that on the abandoned side the surface is being constantly raised by deposits of material which the water, more sluggish on this side, can no longer hold. As the river shifts its position in the valley, a strip of land of varying width is formed each year to be gradually assimilated to the permanent valley (see Diagram No. II).

If, now, we take the more general view and regard the entire valley as one homogeneous product, we can better study the process by which it has been formed. Beginning with the channel of the river we shall find that, except where crossing the bed, its cross-section presents a figure approaching more or less closely to a right-angled triangle with the right angle at the bottom, or deepest place. One side will then be formed by a steep wall or bank, which may become perpendicular above the surface of the water, but is not usually so below. The other side of the triangle represents the general bottom of the river, which gradually grows more shallow toward the remote side of the river-bed.

At the deepest point, fresh erosion or corrosion is taking place, while the steep bank adjacent is being rapidly worn away (see Diagram No. III).

The features to be described can only be satisfactorily observed in time of low water. The bank above the river on the deep side is then generally very high, often rising perpendicularly twenty feet or more above the surface of the water. This high bank, thus exposed to the view of the navigator in the river, affords a most excellent opportunity of studying the manner in which the material composing the general valley has been deposited, the various agencies that combined to form the deposit, and the approximate time required for the accumulation of a given thickness of this alluvium.

These walls of loose earth are always very conspicuously stratified, the layers having various thicknesses and different colors. As many as a dozen distinct strata can usually be seen, often very definitely marked off from one another. The color of these layers enables the observer to determine, with considerable certainty in any case, whether it was due to a wash from the neighboring hills, whose color can be directly compared, or to a deposit from the river itself, brought in time of flood from points higher up, or, as is often the case, from vegetable mold which long immunity from disturbance has allowed to accumulate. Some idea of the time occupied in the total deposit may be formed from the presence of forests of cottonwood (*Populus monilifera*, Ait.) which line the river. These trees are sometimes of great size, measuring three or four feet in diameter, and, although the cottonwood is a rapidly growing tree, there can be no doubt that many of the trees are two or three hundred years old. But the mere presence of these forests standing upon the surface of the latest stratum of the general valley is by no means the only time-measure we have. A careful observer, though merely walking among them, might perceive that some of them have their bases buried to some little depth with alluvial earth or vegetable mold. This fact, which would escape any one who was not specially looking for evidences of it, becomes striking when the edges of the strata are viewed from the river.

As the river wears away the previously formed deposits of its valley, it at length approaches the portion that has had time to become covered with these forests. Undaunted, it attacks this portion also, and begins the work of felling the trees. Their roots are laid bare, the solid earth on which they have stood for ages is swept away, and one after another these ancient giants succumb to the rapacity of the waters, and fall powerless into the raging current. Every step in the process by which this result is accomplished may be seen by watching these eroded banks while floating down the stream. The river, as it passes one of these doomed forests, is choked with snags, through which the surging waters roar, and among which it is extremely difficult and often dangerous to guide a boat. These snags are of all

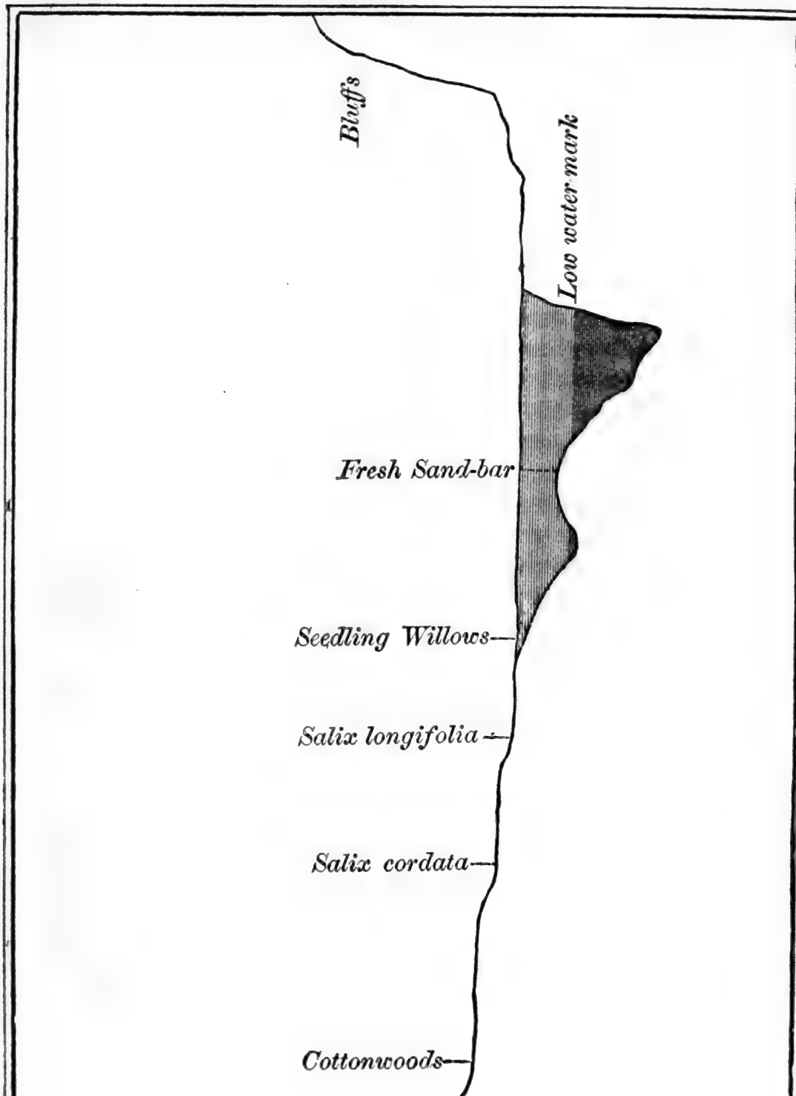

DIAGRAM NO. III.—CROSS SECTION OF RIVER VALLEY.

ages, from the old "sawyers" that have bowed before the current with rhythmic regularity perhaps for centuries, to the freshly-felled monarchs still bearing their green leaves of the season.

But the fact of chief interest is the presence of trees on the brink of these eroded walls, whose still living and healthy trunks are laid bare to a depth of several feet below the present surface of the ground. In some cases the subterranean portion occupies as many as four or five feet of the base of the trunk, descending through a number of distinct strata. But even at much greater depth there are frequent and unmistakable relics of ancient forests long since destroyed, or, as it were, buried alive. At depths of ten or twelve feet below the present surface, old stumps, with roots and remains of trunks, are brought to light by the inroads of the river. The trees which these represented must have been buried deeper and deeper, in the same manner as existing ones are proved to be undergoing burial, until, unable longer to perform the functions of circulation, they died, and all decayed except these deeply buried parts. Sometimes even these are gone, and naught remains beyond a reddish stain against the vertical wall to mark the spot where once there flourished upon the then surface of the valley a large and healthy tree (see Diagram No. IV).

The method thus far described of studying the mode of formation of the river-valley is that of *analysis*—the observation of the action of the water in disintegrating it. But we may also employ the method of *synthesis*, and study the manifest process of valley-building which takes place simultaneously. The river is always loading up on one side, and unloading on the other. The deepest part of the river near the high banks, as it sweeps round the great bends, is also the swiftest. The current grows slower and slower in the direction of the opposite shore, and at the same time the water grows more and more shallow, until at last a sand-bar is reached gradually rising out of it. If this proves to be the mainland, the case is simple, and we will first consider this simple case. This sand-bar was formed at the last period of high water in the spring and early summer. It therefore consists of sand only, without vegetation. It may have a width of fifty or a hundred feet when it ceases, and a distinct rise occurs, with a little terrace of sand, thickly covered with seedling willows, all belonging to one species (*Salix longifolia*, Muhl.), and bearing no other vegetation. The sand is still damp, being saturated with water from the river. This land is two years old. A short distance farther back another similar terrace is reached, bearing a thicket of this same willow, but it is now two to four feet high, and fruit-bearing. The land is here three years old. Another remove brings us to a third terrace, having larger willows and some other vegetation, such as is not injured by periodical floods flowing over it. This four-year-old soil is darker in color and firmer. It may complete the river-bed proper, or there may be still another terrace. As we recede from the river, these old river-bed marks become

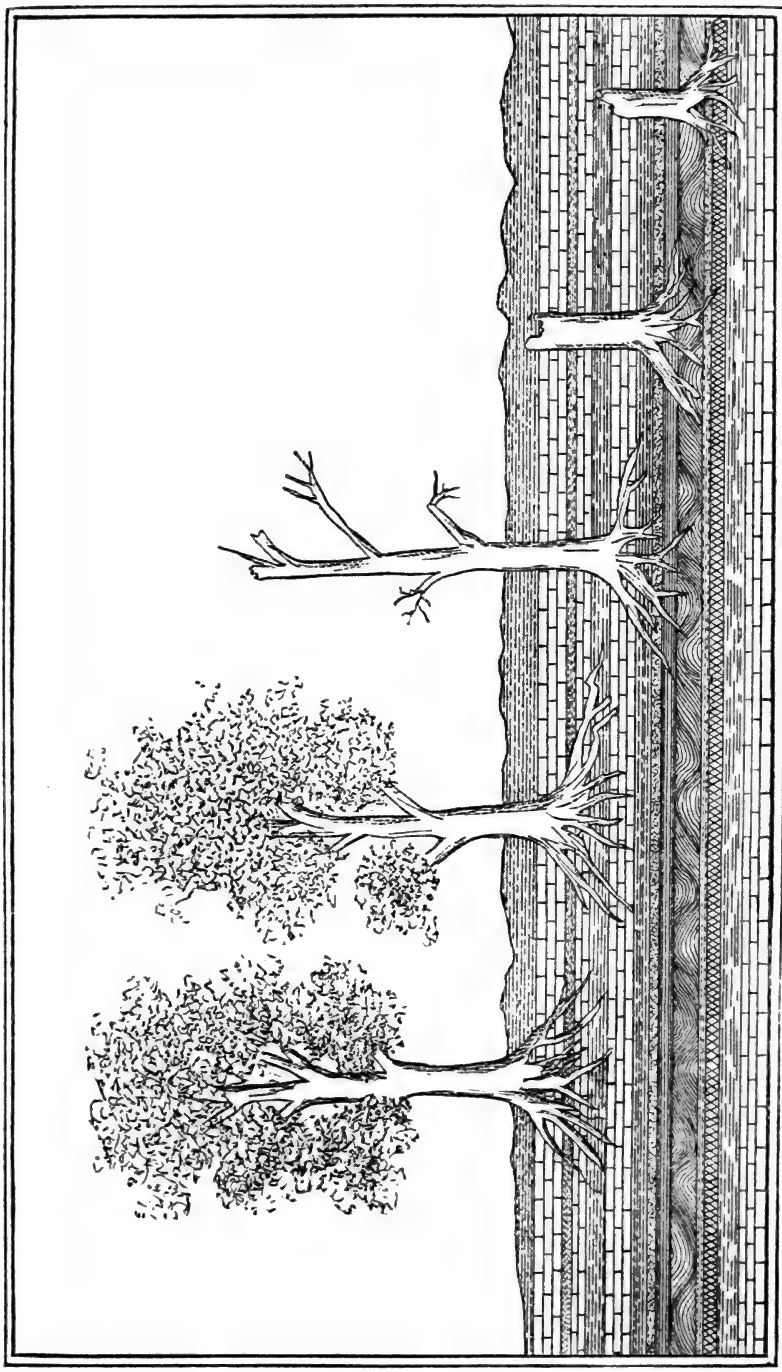

DIAGRAM NO. IV.—EXPOSED SECTION OF RIVER BANK.

gradually obliterated, and the valley seems to slope away with a gentle upward curve to the foot of the lowest hills. As soon as we are fairly out of the present river-bed the little willow gives way entirely to a large one (*Salix cordata*, Marshall), popularly known as the diamond willow. This species often grows very dense and in large clumps, forming an almost impenetrable thicket. It monopolizes the soil, and renders approach to the river difficult. It is at a point still more remote that the growth of cottonwoods begins, and these may form a belt half a mile to a mile in width. From the outer edge of these cottonwood-forests the plain commences, and stretches back, not only across the remainder of the valley, but far away in an uninterrupted sea of grass, until another river system is reached (see Diagram No. III).

Such, in its general outline, may be conceived to be the normal character of the Missouri and Yellowstone Rivers after they pass the mountainous part of their course and enter the portion where wide valleys prevail. But there are, of course, many deviations from this normal type. The fires may have destroyed the cottonwoods and willows that line the river and occupy most of its bed, and an unbroken plain may extend down to the sand-bars upon its banks. These sand-bars may form islands around which quite brisk currents flow even in the dry season. Sometimes, as at Spread-Eagle Bar, on the Missouri, a number of such bars occur, with shallow currents between them, wearing them away along clean-cut faces, and shifting their position from place to place, giving great width to the river. Large islands are often formed, which have accidentally escaped the denuding process, and, being beyond the reach of fires, become covered by a heavy growth of timber. Sometimes the bed of the river lies between two similar high banks, more or less central in the valley, showing that, instead of continuing to approach the bluffs on one side, its erosive action has from some cause been arrested or reversed. In such cases there is occasionally found a nearly equal current against each bank, but usually, even here, the main channel is snug against one of the walls, which it is rapidly carrying away, while the opposite wall has an ancient or obsolete appearance, with shoals or bars at its base. Of course, the entire configuration of the country is modified by the occurrence at short intervals of tributary streams with their valleys. These streams, in spring, contain considerable water; but, throughout the summer and autumn, most of them are perfectly dry, at least at their point of junction with the river, whatever water they receive from rains or springs being evaporated in their passage across the arid plains. One is greatly astonished to find no water, or only a rivulet, at the mouths of what are called rivers, and which drain hundreds of square miles of country.

But the Missouri and Yellowstone themselves never go dry. They are large and rapid streams at the dryest seasons of the year, and their turbid waters surge past like a resistless tide. They wear down their valleys by slowly crossing and recrossing them, like a turner's chisel. Once at their limit on a given side, they may be imagined to halt and turn back. The form of the bottom is changed and the point of greatest activity transferred from one side to the other; the sand-bars are first removed, and then the willow-belt is carried away; next they attack the forest of cottonwoods, and mercilessly sacrifice these; still undaunted, they invade the higher parts of the valley, wear away wide stretches of plain, and slowly march up to the foot of the adjacent hills and mountains, which they also attack and undermine, until, checked by the increasing quantity of *débris*, and driven back by the very magnitude of their own trophies, they beat a retreat, only to repeat for the thousandth time the process which we have thus hastily sketched.

AIMS OF THE STUDY OF ANTHROPOLOGY.*

By Professor WILLIAM H. FLOWER, F. R. S.

ONE of the great difficulties with regard to making anthropology a special subject of study, and devoting a special organization to its promotion, is the multifarious nature of the branches of knowledge comprehended under the title. This very ambition, which endeavors to include such an extensive range of knowledge, ramifying in all directions, illustrating and receiving light from so many other sciences, appears often to overleap itself and give a looseness and indefiniteness to the aims of the individual or the institution proposing to cultivate it.

The old term ethnology has a far more limited and definite meaning. It is the study of the different peoples or races who compose the varied population of the world, including their physical characters, their intellectual and moral development, their languages, social customs, opinions, and beliefs; their origin, history, migrations, and present geographical distribution, and their relations to each other. These subjects may be treated of under two aspects: first, by a consideration of the general laws by which the modifications in all these characters are determined and regulated—this is called general ethnology; secondly, by the study and description of the races themselves, as distinguished from each other by the special manifestations of these characters in them. To this the term special ethnology, or, more often, ethnography, is applied.

Ethnology thus treats of the resemblances and differences of the modifications of the human species in their relations to each other, but anthropology, as now understood, has a far wider scope. It treats of

* From the President's address, delivered at the anniversary meeting of the Anthropological Institute of Great Britain and Ireland, January 22, 1884.

mankind as a whole. It investigates his origin and his relations to the rest of the universe. It invokes the aid of the sciences of zoölogy, comparative anatomy, and physiology; and the wider the range of knowledge met with in other regions of natural structure, and the more abundant the terms of comparison known, the less risk there will be of error in attempting to estimate the distinctions and resemblances between man and his nearest allies, and fixing his place in the zoölogical scale. Here we are drawn into contact with an immense domain of knowledge, including a study of all the laws which modify the conditions under which organic bodies are manifested, which at first sight seem to have little bearing upon the particular study of man.

Furthermore, it is not only with man's bodily structure and its relations to that of the lower animals that we have to deal; the moral and intellectual side of his nature finds its rudiments in them also, and the difficult study of comparative psychology, now attracting much attention, is an important factor in any complete system of anthropology.

In endeavoring to investigate the origin of mankind as a whole, geology must lend its assistance to determine the comparative ages of the strata in which the evidences of his existence are found; but researches into his early history soon trench upon totally different branches of knowledge. In tracing the progress of the race from its most primitive condition, the characteristics of its physical structure and relations with the lower animals are soon left behind, and it is upon evidence of a kind peculiar to the human species, and by which man is so pre-eminently distinguished from all other living beings, that our conclusions mainly rest. The study of the works of our earliest known forefathers, "prehistoric archæology," as it is commonly called, although one of the most recently developed branches of knowledge, is now almost a science by itself, and one which is receiving a great amount of attention in all parts of the civilized world. It investigates the origin of all human culture, endeavors to trace to their common beginning the sources of all our arts, customs, and history. The difficulty is what to include and where to stop; as, though the term "prehistoric" may roughly indicate an artificial line between the province of the anthropologist and that which more legitimately belongs to the archæologist, the antiquary, and the historian, that the studies of the one pass insensibly into those of the other is an evident and necessary proposition. Knowledge of the origin and development of particular existing customs throws immense light upon their real nature and importance; and, conversely, it is often only from a profound acquaintance with the present or comparatively modern manifestations of culture that we are able to interpret the slight indications afforded us by the scanty remains of primitive civilization.

Even the more limited subject of ethnology must be approached from many sides, and requires for its cultivation knowledge derived from sciences so diverse, and requiring such different mental attributes and systems of training, as scarcely ever to be found combined in one individual. This will become perfectly evident when we consider the various factors or elements which constitute the differential characters of the groups or races into which mankind is divided. The most important of these are:

1. Structural or anatomical characters, derived from diversities of stature, proportions of different parts of the body, complexion, features, color and character of the hair, form of the skull and other bones, and the hitherto little-studied anatomy of the nervous, muscular, vascular, and other systems. The modifications in these structures in the different varieties of man are so slight and subtile, and so variously combined, that their due appreciation, and the discrimination of what in them is essential or important, and what incidental or merely superficial, require a long and careful training, superadded to a preliminary knowledge of the general anatomy of man and the higher animals. The study of physical or zoölogical ethnology, though it lies at the basis of that of race, is thus necessarily limited to a comparatively few original investigators.

2. The mental and moral characters by which different races are distinguished are still more difficult to fathom and to describe and define, and, although the subject of much vague statement, as there are few people who do not consider themselves competent to give an opinion about them, they have hitherto been rarely approached by any strictly scientific method of inquiry.

3. Language.—The same difficulties are met with in the study of language as in that of physical peculiarities, in the discrimination between the fundamental and essential and the mere accidental and superficial resemblances; and in proportion as these difficulties are successfully overcome will the results of the study become valuable instead of misleading. Though the science of language is an essential part of ethnology, and one which generally absorbs almost the entire energies of any one who cultivates it, its place in discriminating racial affinities is unquestionably below that of physical characters. Used, however, with due caution, it is a powerful aid to our investigations, and, in the difficulties with which the subject is surrounded, one which we can by no means afford to do without.

4. The same may be said of social customs, including habitations, dress, arms, food, as well as ceremonies, beliefs, and laws, in themselves fascinating subjects of study, placed here in the fourth rank, not as possessing any want of interest, but as contributing comparatively little to our knowledge of the natural classification and affinities of the racial divisions of man. When we see identical and most strange customs, such as particular modes of mutilation of the body, showing themselves among races the most diverse in character and

remote geographically, we can not help coming to the conclusion that these customs have either been communicated in some hitherto unexplained manner, or are the outcome of some common element of humanity, in either of which cases they tell nothing of the special relations or affinities of the races which practice them.

This subject of ethnography, or the discrimination and description of race characteristics, is perhaps the most practically important of the various branches of anthropology. Its importance to those who have to rule—and there are few of us now who are not called upon to bear our share of the responsibility of government—can scarcely be overestimated in an empire like this, the population of which is composed of examples of almost every diversity under which the human body can manifest itself. The physical characteristics of race, so strongly marked in many cases, are probably always associated with equally or more diverse characteristics of temper and intellect. In fact, even when the physical divergences are weakly shown, as in the case of the different races which contribute to make up the home portion of the empire, the mental and moral characteristics are still most strongly marked. As it behooves the wise physician not only to study the particular kind of disease under which his patient is suffering, and then to administer the approved remedies for such disease, but also to take into careful account the peculiar idiosyncrasy and inherited tendencies of the individual, which so greatly modify both the course of the disease and the action of remedies, so it is absolutely necessary for the statesman who would govern successfully, not to look upon human nature in the abstract and endeavor to apply universal rules, but to consider the special moral, intellectual, and social capabilities, wants, and aspirations of each particular race with which he has to deal. A form of government under which one race would live happily and prosperously would to another be the cause of unendurable misery. No greater mistake could be made, for instance, than to apply to the case of the Egyptian fellah the remedies which may be desirable to remove the difficulties and disadvantages under which the Birmingham artisan may labor in his struggle through life. It is not only that their education, training, and circumstances are dissimilar, but that their very mental constitution is totally distinct. And when we have to do with people still more widely removed from ourselves—African negroes, American Indians, Australian or Pacific islanders—it seems almost impossible to find any common ground of union or *modus vivendi*; the mere contact of the races generally ends in the extermination of one of them. If such disastrous consequences can not be altogether averted, we have it still in our power to do much to mitigate their evils.

All these questions, then, should be carefully studied by those who have any share in the government of people of races alien to themselves. A knowledge of their special characters and relations to one another has a more practicable object than the mere gratification of scientific curiosity; it is a knowledge upon which the happiness and prosperity, or the reverse, of millions of our fellow-creatures may depend.

WHERE AND HOW WE REMEMBER.

By M. ALLEN STARR, M. D.

IF you examine the brain of a dog, or an ape, or a man, you will see that it is made up of two kinds of substance, gray and white. The gray substance, which is formed of round bodies of nervous matter called nerve-cells, is spread out in a thin layer over the entire surface of the brain. The white substance constitutes the center and body of the organ, and consists of white threads or nerve-fibers which pass in various directions through the brain and end in the cells of the gray matter. It is the office of the white fibers to convey messages; it is the office of the gray cells to dispatch them, or to receive and register them.

If a brain be properly torn apart, it can be shown that many of the white threads are collected into bundles. These bundles, each of which contains many thousand threads, can be separated from one another and followed to their terminations. It will then be found that each bundle, or tract, as it is called, connects some one organ of the body with some one region of the gray matter on the surface of the brain. For example, one tract joins the muscles of one half of the body with the lateral part of the opposite half of the brain; another ascends from the surface of the body, being made up of many fibers, each of which comes from one little area of skin, and this tract ends in the surface of the brain just behind the first one; another bundle comes from the eye and goes to the posterior part of the brain. So too the ear, the nose, the tongue, send in their bundles, and each of these goes to a definite and separate region of the surface. And thus, as every part of the body is connected by its own tract with its own part of the gray matter, we can imagine upon the surface of the brain a map of the entire body laid out, and can say, as Meynert does, that the surface of the body is *projected* upon the surface of the brain.

Each of the little white threads, like an electric wire in a cable, is insulated from every other by a sheath. It is therefore impossible for a message sent from one end of the thread to leave it; the message must go to the other end of the thread. Therefore, an irritation set up in any organ of the body is always transmitted to that part of the brain with which the organ is joined, and can not reach any other part directly, although it may do so indirectly, by means of association fibers which join the different regions with one another. The anatomy of the brain, thus studied, gives a clear indication that the different regions of its surface govern different organs of the body, and that each region has a distinct function to perform.

It is an admitted fact that an irritation set up at one end of a sensory nerve and sent to the brain produces a change of state in the gray cells which receive it. That change of state is known to us as the conscious perception of a sensation. The conscious perception does not occur in the organ irritated, nor in the nerve which carries the irritation. It occurs in the brain. The perception of an object seen does not take place in the eye, nor in the optic nerve, but in the posterior part of the brain where the tract from the eye terminates in gray cells. In like manner each sensation is consciously perceived in that part of the brain with which the sensory organ is connected whose irritation produced the sensation.

Being perceived, the sensation is in some way registered and preserved, so that when a second similar irritation is sent inward we not only perceive it, but recognize it as a matter of former experience. But, independently of a second perception, we have evidence that the first is preserved in the fact that we can call it up to consciousness by a voluntary effort, and make it, by means of memory, an object of thought. In both these processes the same part of the brain is in action which originally perceived the sensation. But, as sensations are perceived in various regions, it becomes evident that memories are stored up in various regions. If this is so, our various kinds of memory must be independent of each other, and one may be lost while others remain. We shall soon see that this is the fact.

If you lay bare the brain of a dog, and carefully cut out all the posterior part of both halves or hemispheres, you will find, when the dog recovers from the operation, that it is totally and permanently blind. It can smell, and hear, and taste. It can run about, and can perceive sensations of all kinds except those of sight. If from the brains of other dogs you cut out other parts, but leave the posterior part untouched, sight will not be affected in any case. These physiological experiments show that perceptions of sight occur in the posterior parts of the brain, the parts to which we have already traced the white threads from the eye.

If, instead of cutting out the whole of the posterior part of the brain, you select the central portion of the posterior part, leaving a ring of tissue about it uninjured, the result is more interesting. (See Fig. 1, A_1.) After a few days, when the wound is healed, you will find that the dog's hearing, smell, taste, motion, and general sensation are in no way affected. The animal runs about the room, and, unlike the first dog, either avoids or jumps over any obstacle which may be put in his way. He can therefore see the obstacle. But the sight of other dogs, or of men, whom he used to recognize with signs of pleasure or dislike, no longer affects him at all. However hungry or thirsty he may be, he no longer looks for his food and water in their usual places, and when they are put before him he does not seem to know them as food and water until his nose is put into them, when he recognizes them by other senses than sight. The sight of the whip, which used to make him run into a corner, does not frighten him any more, though he jumps when he hears it snap. He used to give his paw when the hand was held out for it. Now he will not do so until the word paw is spoken, when he holds it up as before. The dog is not blind, but he has lost the power of recognizing objects formerly recognized by sight. He has been deprived, by the operation, of his sight-memory pictures, or sight-imaging power. He has been put back, as far as one sense is concerned, into the condition in which he was when born—that is, destitute of knowledge acquired by sight-perception. He acts just like a puppy; for he soon begins to smell and lick objects in an inquiring way, and to run to and examine curiously things with which he was formerly familiar. He sees these things, he learns again to know them; in a word, he begins at once to lay in a new store of memory-pictures. It is only necessary to put his nose into water a few times; after that he looks for and finds it when he is thirsty. Then he begins to know his master. The whip soon becomes again a dreaded object. And in the course of two or three months he has gained a new set of memories and recognizes objects just as before the operation.

In the first dog, the entire posterior part of the brain was removed, and the dog was made permanently blind. In the second dog, a portion of this part of the brain was cut out, and the dog was deprived of his sight-memory. He was, however, able to recover. And, if by successive operations the experiment be repeated on the same dog, it will be found that recovery is always possible until the entire posterior part of the brain is removed, when, like the first dog, he becomes permanently blind. The recovery then was possible because around the area cut out there was left a ring of gray matter which was in connection with the eye; and in this ring of gray matter, which formerly contained no memory-pictures, the new memory-pictures were stored. All the posterior part of the brain in the dog is, therefore, a *potential* area for sight-memories. The *actual* area of sight-memories occupies only a part of the potential area. If the actual area is cut out, but a part of the potential area remains, the dog is temporarily deprived of sight-memory, but can recover. If the potential area is entirely extirpated, the dog remains blind, and can never regain his memories. The distinction between actual and potential memory is important, as we shall see when we come to similar phenomena in man.

The experiments just described were first made by Hermann Munk, Professor of Physiology in the University of Berlin, and they have been confirmed by many other experimenters. What has thus been proved of the location of perception by sight, and of sight-memories in the posterior part of the brain, has also been proved of other senses and their memories. The perception of sounds and sound-memories are destroyed when the lower lateral part of the brain (the temporal region) is injured, but are not affected as long as this region remains intact. When the anterior portion of this region is destroyed, the animal becomes deaf to sounds of a low pitch; when the posterior portion is injured, high notes are no longer heard. If the region is entirely extirpated, the animal is totally and permanently deaf. If it is only partly extirpated, the animal loses all memory of words or commands formerly recognized, attaches no meaning to the cry of its puppies, to the snap of the whip, or to its master's whistle. The perception of touch and its memories are destroyed when the upper lateral portion of the brain is injured (the parietal region). Voluntary motion is suspended when the antero-lateral portion is destroyed. If the destruction of this part is complete, the paralysis is permanent; if not, recovery is possible. In all these regions the distinction between actual and potential obtains: if the actual area only is cut out, the acquisitions already gained are lost; but, as long as some of the potential area remains, the power to acquire is present and recovery is possible.

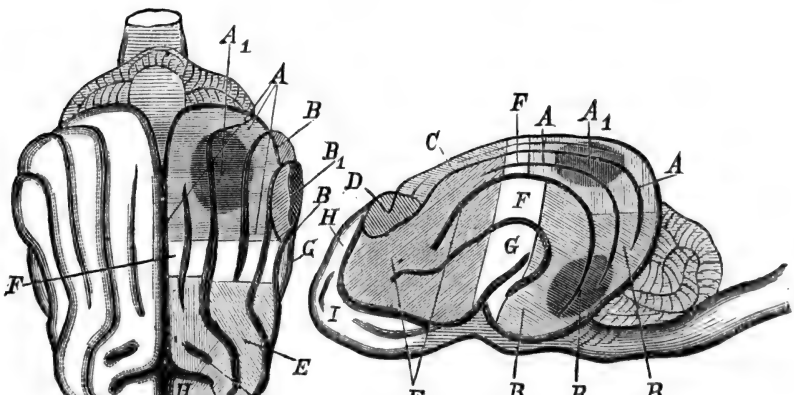

FIG. 1.

BRAIN OF A DOG. DIAGRAM OF MUNK.

A. Visual area; *potential* area of sight-memories.
A_1. Visual area; *actual* area of sight-memories before operation.
B. Auditory area and potential area of sound-memories. B_1. Actual sound-memories.
C. Area governing motion and sensation in hind-leg of the opposite side.
D. Area governing motion and sensation in fore-leg of the opposite side.
E. Area governing motion and sensation in head of the opposite side.
F, *G*. Area governing motion of the muscles of the eye and ear respectively of the opposite side.
H, *I*. Area governing motion and sensation in neck and body of the opposite side.

Thus, by experiment, a number of regions are mapped out on the surface of the brain and the function of each is determined. When the results of the physiologists are compared with those of the anatomists, they are found to agree. The area of the brain which the physiologist has shown to govern sight has been shown by the anatomist to be connected by means of insulated white nerve-fibers with the eye. The area which, one says, governs touch, the other says is connected with the skin. The area which one proves to be concerned with voluntary movements, the other finds to be joined to the muscles. Thus the two independent lines of evidence unite in indicating that each region of the brain has its own work to do, its own memories to preserve.

While the anatomical evidence in favor of the localization of memories is as strong in the case of man as it is in that of the dog or ape, the physiological evidence is wanting. Physiologists lament that they can not experiment upon man, and psychologists are slow to admit that these experiments throw any light upon man's mind and its action. Just here, however, the study of disease comes in to help out our knowledge. Disease may be regarded as an experiment of Nature to satisfy both physiologists and psychologists, and its results are the more satisfactory, since man is an animal who can describe his sensations during the experiment, as no other animal can. The nature and value of the evidence for the localization of memories to be derived from the study of disease will be clear after the blood-supply of the brain in man is understood. Every artery divides and subdivides as it passes outward from the great central artery of the body—the aorta —so that the vascular system may be likened to a tree, with trunk, boughs, branches, and twigs. Each terminal division of an artery supplies with blood a little cone-shaped mass of brain, the base of the cone being the gray surface of the brain, and its apex being the point of entrance of the little artery. In the brain the terminal branches of the arteries do not run into each other, as in some organs, so that each little cone, like the leaf on the tree, is independent of adjacent cones and hangs upon its own arterial twig. Now, it is evident that anything which plugs up the artery is going to cut off the blood, and therefore the nutriment from the little cone of brain, and then the little cone will wither and die. The larger the artery plugged, the greater the surface of brain destroyed. This is the process of disease known as embolism or thrombosis. But such a destruction of brain-tissue in man corresponds to the artificial destruction of brain-tissue in the dogs experimented upon, with this advantage in the case of man, that the shock of the operation is avoided. The experiments of Nature and of the physiologist are therefore parallel. The only difference is in the order of the observation. The physiologist cuts out a definite part and observes the result. The pathologist observes the result of Nature's experiment by watching the symptoms of his patient, and, after the patient's death, he can ascertain the position of the part diseased. Now, if the old theory be true, according to which the brain acts as a whole, and its various parts do not possess distinct mental functions, a limited area of disease in one part may impair the mental powers but will not produce a loss of one function. If, on the contrary, the new theory be true—the one to which the anatomical arrangement and the physiological experiments point—that each part of the brain has its own work to do, a limited area of disease will interfere with the work of the part diseased—will produce a loss or impairment of one function, and will not affect all the powers.

The following instance shows that pathology supports anatomy and physiology, and that the localization of functions and memories is no longer a matter of question among scientists:

Not long ago a man was brought into Bellevue Hospital, in this city, suffering from fever, headache, delirium, and stupor, which had developed after a blow upon the head. In addition to these symptoms, he had a paralysis of the muscles on the back of the fore-arm, so that he could not raise his left hand. The general symptoms indicated the presence of an abscess in the brain. To the surgeon, familiar with the anatomy and with the physiological experiments upon animals, the paralysis of the arm-muscles indicated that the abscess was situated in that part of the brain whose function it was to raise the hand. He therefore sawed through the skull over the supposed site of the abscess, and, although the hole which he made was only large enough to admit his little finger, the abscess was found lying just beneath it, and was emptied.

Such a case shows that the study of localization may aid in saving life. The following cases of loss of a definite kind of memory, occurring suddenly, and accompanied by symptoms which indicated the situation of the disease in the brain, remind one very forcibly of the physiological experiments described, and afford positive proof that powers of sensation and memory, as well as the power of motion, may depend upon the integrity of definite regions of the brain:

An intelligent gentleman, while playing billiards, suddenly became aware of the fact that he could see but one half of the ball at which he was aiming. He had become blind in the right half of both eyes. Soon after, on attempting to read, he found, much to his surprise, that he could not read. He could see the letters and words, but they conveyed no meaning to his mind, and appeared to him as so many forms—just as a set of Chinese letters do to us. He had lost the power to recognize written and printed language. Singularly enough, he could write as well as ever, but it was impossible for him to read what he had just written. The memory of the motion involved in producing a letter remained, the memory of its appearance was gone. The memory of the motion served to take the place to some degree of the lost memory-pictures, for, when asked to read a word, he would bring up his hand to the page and with his finger trace the form of the letter, and then name it. It was evident that the only means he had of recalling a letter was by going through the motion necessary to write it—in other words, by calling into play his motor-memories. As he was more accustomed to trace written than printed letters, it took him a longer time to recall by tracing printed than written words. But this was not his only defect of memory. He found that many objects formerly perfectly familiar were no longer recognized by sight. He was well acquainted with the streets of Paris, but on going out he now looked at the houses and streets as at those of a new, unknown city, and he was unable to find his way about. The loss of memory did not consist simply in a failure to recognize objects seen, it involved his power to call up to his mind objects formerly well remembered, places well known, faces, scenes of his childhood, etc. The blindness in the right half of both eyes indicated that the disease was situated in the posterior part of the left half of the brain, for this has been found diseased in nearly thirty cases of similar defects in vision in which an examination of the brain was made. The loss of memory of objects seen indicated that in that part of the brain in which the perception by sight occurs were located nerve-cells whose integrity was necessary to the existence of the sight-memories lost. The case demonstrated conclusively that sight-memories lie in the posterior part of the brain. The mental vigor of this man was good. His other faculties, his other perceptions and memories, were not affected. He was not paralyzed; but, as far as reading was concerned, he had been put back into the exact condition in which he was when as a boy he began to learn to read. And when the writer saw him last, in the wards of Charcot's great hospital in Paris, he was studying away at his alphabet like a school-boy of six years.*

This is not an isolated case. In the same hospital, at the same time, was another gentleman who had been remarkable for the excellence of his memory. It had always been possible for him to acquire easily, and he had only to read a passage carefully in order to remember it verbatim. He also had considerable talent in sketching, and was in the habit of drawing any figure or view which pleased his eye. His memory of music, or of things heard, was less active and reliable than his visual memory. One day he suddenly noticed a peculiar change in his power of mental action, which alarmed him very much. He found that everything about him seemed strange and unfamiliar. His visual memory was entirely gone, so that he no longer recognized objects or faces, and could not call up to his mind the forms or colors of well-known things. The town in which he lived seemed an unknown place. He looked at its streets, its houses, its statues with curiosity, as at those of a strange city. The same was true of Paris, to which he came for medical advice, and where to his surprise he could not find his way about. At the same time he lost the power to sketch, being unable to remember the object to be drawn long enough to draw it, and being unable to recall the appearance of lines and shading in a picture. He found that he could not recall the faces of his wife and children, and when they came to him he only

* This case was fully reported by Charcot, in the "Progrès Médicale," May, 1883.

recognized them by the sound of their voices. He even forgot his own appearance, and, being in a large public gallery, and seeing, as he supposed, some one in a doorway barring his passage, he stepped forward to ask the stranger to let him pass, when by the motions he realized that it was his own figure seen in a large mirror. This loss of visual memory extended to memories of his childhood as well as to those acquired recently. It interfered much with his power of reading. In reading a book or in adding a column of figures it was necessary for him to have recourse to movements of articulation of his tongue and lips in order to understand what he read or in order to add. While formerly he could remember easily what he read, he now was obliged to read aloud anything he desired to commit to memory, and thus to learn it by impressing his auditory memory. An interesting detail of the affection was the fact that in his dreams he no longer saw objects, but merely heard sounds or words.*

Thus he had been deprived entirely of one class of memories, while all others were still at his command. As a consequence, there had come about a complete change in his character, which can easily be understood when one considers how largely one's thinking is made up of the comparison of one set of memories with another, and how frequently the whole circuit of one's thoughts and actions centers about one group of memories. This man was an artist, and in a moment all the powers, the result of long study and labor, which enabled him to perform and enjoy his life-work, were taken away. In this case, as in the first one related, the disease must have been situated in that part of the brain where visual memories are stored, viz., in the posterior part.

Such a loss of visual memories may be temporary, as is well illustrated by the case of a city district messenger-boy, who found on several occasions that he suddenly lost his way and could not recognize streets with which he was usually familiar, so that he was obliged to ask a policeman to take him to his home; where, however, in the course of a few hours he recovered his memory of places and of faces which he had lost. In this case, which may be regarded as one form of epilepsy, the loss of memory can be explained by the hypothesis that a spasm of the arteries occurred in the posterior part of the brain, just as such a spasm in those of the face gives rise to a sudden pallor.

Visual memories are not the only ones to be temporarily or permanently lost. There is another class of cases whose study gives unmistakable evidence of the localization of memories in that part of the brain in which the original perception occurred. It has been stated that the auditory nerve sends a tract to the lower lateral portion of the brain (the temporal region), and that destruction of this region in animals gives rise to deafness. When this part is injured by disease in man, a peculiar condition is observed, known as word-deafness.

* This case is reported in the "Progrès Médicale," July 18, 1883.

This can be readily explained by a review of what occurs in answering a simple question. When you answer a question, the following processes have taken place: 1. You have heard the words of the question. 2. The words have been recognized as known words, and have awakened a corresponding concept. 3. The concept has started a train of thought which has led you to a conclusion. 4. You have formulated your conclusion in words. 5. You have voluntarily set in motion a mechanism consisting of your throat, lips, and tongue, to speak the words. 6. This mechanism has responded to the effort, and has produced the sound of your reply. Now, any one of these processes may be interfered with, in which case you will not answer the question. If you are deaf, you may not hear it. If it is spoken in a language which you do not understand, the words will fail to be recognized, as the sounds will not awaken any memory or concept.

But the words addressed to a child are at first mere sounds to him, and it is only by repeated reiteration of the word in connection with the object or act indicated by it that the child has acquired a knowledge of its meaning. If these acquired bits of knowledge stored up in the memory in childhood are blotted out, the meaning of the word will be lost, and the effect will be the same as if the word had never been learned, or as if it were spoken in an unknown language. This is the condition known as word-deafness, or loss of memory of the sound and meaning of words. It is not an uncommon form of brain-disease, and the symptom and the location of the disease have been connected in so many cases that it is now possible to state that in right-handed persons such a condition is due to disease of the left temporal region, and in left-handed persons to disease in the right temporal region. But such a defect will not only prevent one from recognizing a word when spoken, it will blot out the memory of words, and the power of recalling the words which you desire to use. Therefore you will be unable to answer the question, not only because you do not understand it, but because, if you did understand it—as you might be made to do by appropriate gestures—you could not find words in which to reply. Here, then, another special class of memories, to the exclusion of all others, is blotted out by a localized disease.

But let us follow the process a little further. Suppose you have heard the question, and understood its import, and the concept awakened has set in motion a train of thought which has led you to a proper conclusion, since it is to be supposed that you are neither an idiot nor insane, both of which conditions might interfere with this part of the process; and suppose that your conclusion is formulated in words in your mind. You have still to speak the words before your reply is heard. We will pass by a paralysis of the muscles of the throat or tongue, which would, of course, prevent your speaking, and consider the process of setting in action the voluntary centers which govern speech. You have learned to speak by repeated efforts, at first with imperfect success, later with proper regulation of the tone and effort necessary; which, when acquired, is remembered, so that the words are now clearly pronounced. But this learning to talk is simply the acquiring of memories of definite combinations of muscular action; in a word, of motor-memories. Other examples of motor-memories are the memory of the motions made in playing a musical instrument, swinging Indian clubs, writing, or using various implements of trade. These are all distinct memories, and any one of them alone can be blotted out by disease. But, if the memory of the motions necessary to pronounce the words of your reply is affected, it is evident that you will be as powerless to answer the question as though you did not understand it. If this is the case, the disease will be in a different part of the brain from that affected in the first case. It will lie above and in front of the temporal region, in what is known as the third frontal convolution of the brain. This, too, is established by hundreds of examinations of persons who died with loss of speech.

It thus becomes evident from the study of brain-disease that our visual memories, our auditory memories, our memories of motion, and our memories of speech may each be lost while other memories are unaffected; and further, that a loss of any one of these memories is always due to disease in its own appropriate part of the brain.

One other set of facts remains which confirms in a remarkable manner the theory of the localization of functions. It is well known that organs which are constantly used grow in strength by use. The blacksmith's arm is the favorite example. It is no less true that an organ which is not used withers away. If one carries his arm in a sling for several weeks, it grows thin. Now, a sensory organ, like the eye, is simply a mechanism for the reception and transmission to its corresponding part of the brain of appropriate impulses. Suppose the organ to be destroyed. It is evident that the part of the brain with which it is joined is no longer called into action; it is no longer used, and the result is that it withers. If from a new-born animal you remove an eye, the tract to the posterior part of the brain and that part of the brain will never be called into use, and hence they never develop to a normal size. If a child is born blind, or loses his sight in infancy, the same is true; so that, when in old age he dies, the posterior part of his brain will be found small and shrunken. It is probable that the examination of the brain of a deaf and dumb person would show an atrophy of the speech-centers, although this has not yet been investigated. It is known that if a limb be amputated and the individual lives for twenty years or more, the part of the brain which formerly governed the movements of that limb, and which received sensations from it, will be found shrunken and withered. So that from this class of facts important evidence is derived regarding the parts of the brain which preside over various functions and which preserve their appropriate memories.

If, now, we take models of four brains, and on the first mark out the location of the various areas connected with the various sensory organs as determined by the anatomical connection of the white nerve-threads ; on the second mark out the location of the various areas which physiologists have shown to govern various sensory organs ; on the third mark out the various areas whose disease produces disturbance of action in the various sensory organs, and loss of memories of perceptions by those organs ; and on the fourth mark out the various areas which wither after disease of the various sensory organs—we shall find that upon all four brains the areas belonging to any one organ coincide. We may therefore conclude that each class of sensations

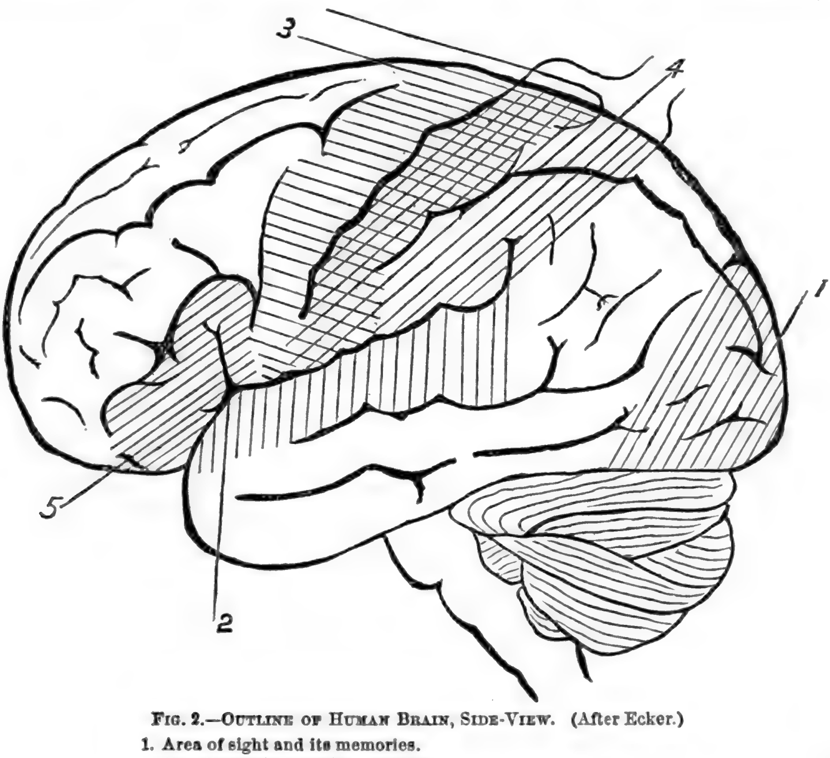

FIG. 2.—OUTLINE OF HUMAN BRAIN, SIDE-VIEW. (After Ecker.)

1. Area of sight and its memories.
2. Area of hearing and its memories.
3. Area of motion and its memories, } upper one third, leg.
4. Area of touch and its memories, } middle one third, arm. lower one third, face.
5. Area of motor speech-memories.

The areas of motion and general sensation coincide to some extent.

and each class of memories has its own definite area of the gray matter on the surface of the brain. Memories of objects seen are located in the posterior part in the occipital region. Memories of sounds heard are located in the lower lateral part in the temporal region. Memories of motions in the limbs, and of touch in those limbs, are located side by side in the central lateral region. Memories of speech are located in the frontal region. It is therefore a mistake to speak of memory as a single faculty of the mind. It is really an assemblage of distinct memories which we possess, each kind of memory being as different from the others both in its nature and in its location as are the different organs of sense through which the original perception came. These various memories are associated with each other, and this association is secured by means of fibers passing between and joining these different areas. It is also a mistake to give memory as a whole a location in one place as the phrenologists do. Our various memories are scattered over the brain in different regions, being distributed at the time of the perception of the sensation remembered in accordance with the anatomical connection of the percipient organ. It is, finally, a mistake to speak of a good memory or a bad memory. The degree of power to remember differs in our various kinds of memory. One man can remember things seen; another can remember things heard; a third is skillful in the performance of certain motions, and may be said to possess a good motor-memory. A fourth acquires languages readily. So each of us has a stronger and a weaker kind of memory, and it is important to recognize this, in order to train and educate the weaker memory up to the level of the stronger one. The memories which we possess are our actual memories. But around these are areas of gray matter still unoccupied by memory-pictures, and in these potential areas new memories can be stored up. The actual area is always extending, the potential area is diminishing, as we acquire new facts. The wider and more varied our knowledge, the greater the actual area of any one memory, and the more complete our command over our inherent brain-power.

THE ASTRONOMY OF PRIMITIVE PEOPLES.

By G. MÜLLER FRAUENSTEIN.

THE geographical ideas of the lower races, as well as those of civilized people, are of both ethnological and psychological interest, and it is my purpose to devote a few lines to the little-worked field which here presents itself to view. The special subject of my essay will be the ideas concerning the earth and the world formed by primitive peoples, especially the ideas of the form of our planet and of the most important sidereal phenomena; and among primitive peoples I shall, for the purpose of this review, include such half-civilized nations as the Toltecs and Aztecs, and the ancient Peruvians.

Men form different notions of the sky and the earth according to their different points of view. The first appearance of the earth is that of an unbounded surface, and the constructive mind forms a corresponding picture of that part of it which is within its vision. Islanders regard their groups as their world, and finish out the picture with fantastic conceptions of the ocean-regions beyond. Highlanders, who, like the ancient Greeks, also see the sea-shore, figure their earth as a cup or a hollowed surface into which the waters run together. The Grecian view held its ground till the Crusades, unaltered even as to its particulars, and is still entertained by the lazzaroni of Naples. People who live in high mountain-regions, and never look upon extensive plains, regard the earth as a sublime range, a massive dome in which peak towers above peak, as the Caucasians do, or as a lofty cone, like the Thibetans. On conceptions like these stand those religious systems which place the seat of the gods, the first home of the human race, or the abode of the dead, among lofty mountains. The Hindoos called Meru, the Thracians Olympus, the residence of the gods. East African tribes, such as the Masais, the Wakamba, the Wakwasi, and the Gallas, say that their gods dwell in Kilimanjaro or Kenia, or a third equally lofty mountain of their regions. And the Indians of the American prairies believe that the happy hunting-grounds of their departed are to be found in the Rocky Mountains.

The conceptions that are formed of the regions of the earth lying outside of vision are equally diversified. In classical antiquity, the earth was imagined to be surrounded by the sea, Oceanus; or the heavenly vault to rest upon mountain-ranges or isolated peaks. The Caroline-Islanders represent the region beyond the Marianne Archipelago, and north of their home, as one in which the sky gradually approaches the earth, and finally rests upon it, but not so closely but what a space is left that a man can creep through. To the Esquimaux of Greenland the sky seems to be a steep, high mountain in the north, around which the stars revolve, while the earth rests upon props that would have decayed, crumbled, and disappeared long ago, if it had not been for the mummery of witches.

From this we may pass to a wider view, which attempts to form an idea of the back side of the earth. The Kamchatkadales conceive that the earth is flat, and that its under side forms a lower world, under which is another land; or as, according to Steller, they expressed it, the earth is the reverse of a sky under which is still another world; so that they consider the world as a vessel of three stories. The conception of the earth as a flat surface lies at the foundation of most of these myths; but there are a few of them that rest on better ideas. According to Newbold, some of the Malays regard the earth as round, like an egg. The Chippewas and Winnebagoes, according to Lawson, and the Duphlas of Assam, regard the earth as a square, with four corners; but the imagination of that shape is exceptional.

What holds the visible world together, and what supports the earth in it, are also questions that have occurred to primitive men; and their attempts to solve these questions also carry with them efforts to account for particular phenomena of the earth's surface, and such convulsions as earthquakes. Some have tried to compare the earth with an egg in a vessel of water, or with the yolk in the egg; and cosmologies involving this idea are widely spread in Southern Asia, Polynesia, and Melanesia. The Tonga-Islanders say that a god they call Maui carries the earth on his back, and whenever he moves, to turn the other side, or falls asleep, there is an earthquake; and the people were accustomed to beat the ground, with a great cry, to make Maui be quiet. The Khasias, in Assam, say that everything would be destroyed by earthquakes if God did not hold the earth in his hands. The priestly philosophy of the Hawaiians figured the earth as a great mass which the earth-shaker, or earthquake-god, laid upon the central fire. The earth on its side supported the sky by means of two or four pillars. The heaven of the Maories and the Soma of the Vedas are also supported by pillars. The manner in which the sky was in the beginning lifted up on these pillars is carefully described in the Polynesian myth, which relates that the gods Maui and Rua together held the sky on their knees, then lifted it upon their backs, and then on their hands. Other stories relate that, while the sky was resting on the broad leaves of the teva-plant, Rua raised it a little higher up by putting sticks under it, and then the stalwart Maui put his hands to it. In Celebes an earthquake is fabled to take place whenever Eber, who is supposed to be the earth-bearer, rubs himself against a tree and shakes his load. The world-bearing frog of the Mongol lamas, the world-ox of the Moslems, and the gigantic Omophore of the Manichæan cosmogony, are all creatures that carry the world on their back or head, and shake it whenever they stretch themselves or turn around. A similar part is performed in European mythologies by the Scandinavian Loki, who is bound with iron chains in his subterranean cave; by Prometheus, trying to break his chains; and by the Lettish Drebkuls. A branch of the Yuma Indians in Colorado are in dread of an evil spirit that is sleeping on Mount Avicome, and causes a slight earthquake when he moves uneasily, and a dangerous one when he turns clear over. The Caribs were accustomed to say, when there was an earthquake, that Mother Earth was dancing. The Iroquois, according to the testimony of many travelers, conceived the earth as an island in the sea, resting on the back of a huge tortoise. Floods occurred whenever the tortoise sank under the water, earthquakes when it shook itself or changed its position. The Hindoos imagined an earth-bearing elephant, standing on the tortoise, and attributed terrestrial convulsions to his motions. The Duphlas of Assam imagined four elephants supporting the four corners of the earth, which had to suffer when either of its bearers became uneasy.

According to the Kamchatkadales, earthquakes originate when the dogs of the earthquake-god, who travels in a sleigh under the ground, shake the fleas in the snow from themselves. The Siberian hunting races perceive in the bones of the mammoth, so often found in their country, evidences of the real existence of underground monsters, whose movements may give rise to earthquakes. According to Livingstone, the natives of Magomoro relate that once when an earthquake occurred, by which rocks were thrown down from the mountains, the wise men of the country got together, and concluded that a star had fallen into the sea, and the consequent swelling of the waves had caused commotions over the whole earth.

Most of the astronomical conceptions of our Polynesian, African, and American brothers are childishly simple and crude enough, but at the same time curious. A very odd belief is that of the Namaqua Hottentots that the sun is a piece of bright bacon, which the people who go in ships draw up in the evening by enchantment, and let down again after they have cut a piece off from it. The Polynesians say that the god Maui holds the sun and regulates his course by means of a rope. In the beginning he hurt the star in catching it and deprived it of half its light, and since then the days have been longer and cooler, and men have been able to work in peace. The Japanese myths fable eight hundred thousand gods holding the sun with a rope, while it is all the time trying to get back into the cave out of which they have drawn it by means of a trick. The Society-Islanders have a story that the sun goes into the sea at night; it plunges in and is extinguished with a great hissing that can be heard away off in the west. And this recalls a story that is mentioned by Strabo. According to Bock, the Dyaks have a myth that the sun and the moon were made by the Almighty out of a peculiar clay which is found on the earth, but is very rare and costly, the vessels made from which, called *guji blanga*, are holy and protect against evil spirits. The settling of the sun's red disk upon the mountain-tops and its final descent behind the hills engaged the attention of dwellers in the regions where the phenomena assumed that character; and the Karens of Burmah and the mountain tribes of America spoke of the sun going down into a deep cleft in the rocks.

In passing over to the numerous myths in which the sun is regarded as a living being, we meet the belief of the Navajos that it is newly set in the sky every morning by a woman. Next, we come to a great number of stories that personify the sun, although they may not make a god of it, and represent its setting as a process of being swallowed by some monster. Sometimes it is a hero, sometimes it is a virgin, which is thus swallowed and afterward released or rejected, as in the Greek stories of Perseus and Andromeda and Hercules and Hesione, the old Norse story of Eireck and the Dragon, and the Teutonic myths of Little Red Riding-hood and the Wolf and of the Seven Little Goats.

Without going into the discussion of sun-worship, of which so much has been written, we may refer to the wide diffusion of the practice in insular and continental Australasia, Northern Asia, and Central America.

Curious are the forms under which many people have figured the sun and moon. The simplest are the disk-forms, with or without rays, which are of frequent occurrence. On a temple of Palenque, while the sun has this form, the moon is represented as a shell-shaped vase or a spiral shell filled with water, out of which a hare is creeping. Squier found similar representations painted on the rocks in Nicaragua. In pictures ascribed to the Toltecs, the four great Mexican gods are bearing the eye-dotted sky on their shoulders and arms, while the sun-god and the moon-god are indicated under the symbols of the tiger and the hare—a form of representation that has extensively spread in North America. In the ancient Kami religion of the Japanese, the moon was worshiped as a fox. The Caffres and the Esquimaux ascribed an independent life to these planets, the latter people holding that they were human beings who had ascended to heaven, and conceiving the Moon to be the younger brother of the female Sun. In Peru the Moon-mother was both sister and wife of the Sun, like Osiris and Isis in Egypt. In the Lithuanian folk-songs the Moon takes the Sun to wife, and the Morning-Star is their daughter. The red Mintiras of the Malay Peninsula regard both Sun and Moon as women. In Southern Australia, among the Mbokobis in South America, and in the old Slavic sagas, the Moon is a man, and to the Khasias of Northwestern India he is the son-in-law of the Sun. By the Hurons the Moon is called the creator of the earth and grandmother of the Sun; in the myths of the Ottawas it is an old woman with a pleasant white face—the sister of the Day-Star. The Chiquitos call the Moon their mother, and the Navajos make it a rider on a mule. Where the planets are worshiped, preference in honors is generally accorded to the brighter and more conspicuous star of day. But the Botocudos of Brazil give the higher place to the Moon, and derive most of the phenomena of nature from it; and in Central America and Hayti are also people who hold the Moon in no less honor. Curiously, these people find their counterparts among tribes of Western, Southern, and Central Africa, who rejoice with dancing and feasts at each appearance of the new moon, and expect an improvement of their condition from its beneficent influence; and they are not so far removed from the superstitious women of civilized Europe and America who wait for the increase of the moon to change their dwelling, to cut their hair, to be married, and to baptize their children. A belief existed among the ancient Mexicans and Peruvians, the Natchez of the Mississippi, and the Appalachians of Florida, that the sun was the radiant abode of dead chiefs and braves. To the Esquimaux of Labrador belongs the honor of having discovered that the moon was the paradise for the good, while the wicked were consigned to a hole in the earth; although some of the South American Indians and the Polynesians of Tokelau may be nearly abreast of them in the competition.

The facts we have adduced abundantly illustrate the various interest with which primitive peoples regard the two principal stars of the earthly sky. They have also their theories, or rather their myths, respecting the periodical changes to which the appearance of these bodies is subject. The phases of the moon are particularly the subject of much concern. In the belief of the Hottentots, the living being we call Moon suffers from a chronic headache, in consequence of which it becomes greatly reduced in appearance by laying its hand on its head. The Caffres bring the Sun into play in accounting for the phenomena, and say that she pursues the Moon and reduces him, but that he is cunning enough to escape, and then recovers his strength. More curious still is the part the waning moon plays in the eyes of some Polynesians, who say that it is eaten from by departed spirits. Another extremely materialistic explanation is found in some Greenland stories to the effect that the Moon pursues his sister the Sun in love. When he has become exhausted and thin, he goes seal-hunting, and disappears from the sky. In time he reappears, well fed, fat, and shining, as the full moon.

Purely fanciful and obscure are the myths in which animals are found in confidential relations with the moon. The Dakota Indians have a fiction of mice that periodically attack the moon to satisfy their hunger, and eat of its substance. An old Slavic saga makes the ruler of the night the husband of the Sun, who faithlessly gives his heart to the Morning-Star. In punishment for this offense, he is cleft through the middle, and must exhibit himself periodically in this plight as a warning example. The Hos, in Northeastern India, also fable the moon split in two and growing together again. In some of the stories these love-attacks become very violent, and then the aggressive party is made to receive a kind of retributive justice; and we accordingly have the spots that are to be seen upon the moon explained by saying that they are the marks which the vexed solar beauty has made upon her pursuer in defending herself against his importunities. Thus, according to Mr. D. Hooker, the Khasias in Northwestern India say that the Moon, an over-ardent son-in-law of the Sun, burns with love for her at each new change, while she, in her aversion, throws ashes into his face, which stick upon it as dark spots. The Esquimaux have two opposite, yet fundamentally harmonious, explanations. One is that the Sun smuts the face of her younger brother, whose attentions have become troublesome; the other, given by Bastian, that her heart warms toward her lover during his periods of darkness, and the spots are the marks left by her sooty hand caressing his face.

A variety of sagas of another kind discover living beings, not in the whole moon, but only in the dark points of its surface. The Hindoos fancy a hare in it, or a deer; the Japanese, a rabbit. According to one of the Namaqua legends, the hare has scratched the moon, and the marks remain, but the animal itself has broken away, and is now continually fleeing before the planet. Who, in the face of such stories, can be oblivious of the general connection between the moon and the hunting goddess, and its personification in identity with her, which figure in the fables of classical antiquity?

A most remarkable fact is the agreement of peoples who have never had anything to do with one another—of South African tribes and the Northern Europeans, the Samoa-Islanders and the ancient Peruvians—in the belief that the spots in the moon represent a creature of our own species. The story of the man in the moon, which may be traced in Europe for some hundred years back, and appears in the old Norse myths, and which still charms our children, prevails in many different versions. The Raratongans recognize in it a departed chief; the Ossetes of the Caucasus, a demon, which they regard with an idolatrous fear; the Namaquas, a higher being, to whom they attach great importance; the Pottawattamie Indians, an old woman; the people of Timor, a spinster; the Mangaians, a busy housewife; and the ancient Peruvians, a courtesan. The Siamese see in it, now a hare, and now a married couple, who cultivate the fields and accumulate heaps of rice.

There remain to be considered the impressions that eclipses of the sun and moon make upon primitive peoples. A large number of their explanations represent the planets as a man and a woman, and sometimes bring in a child to help in producing the phenomena. The Jesuit Le Jeune was told by an Algonquin, in Canada, that the Sun and Moon were man and wife who had a child. When the father took up the little one to caress it, there was an eclipse of the sun; when the mother held it in her arms, an eclipse of the moon. According to the Mintiras of Malacca, the Sun and Moon are two women, of whom the former eats her children, while the Moon hides hers, although she is pledged to eat them too. Enraged at this breach of faith, the Sun chases the Moon around, swallowing her own star at each dawn, while the Moon brings hers out as soon as her pursuer is far enough away. At times, the enemies approach so nearly that the Sun can strike the Moon, and then there is an eclipse. The Hos of India have the same story, with the variation that the Moon, in punishment, is cut in two by the Sun, and has to grow together again. Notwithstanding the frequent recurrence of eclipses, with nothing particularly bad happening after them, most primitive peoples aasociate with them an omen of some great danger to the earth or the moon. The Greenlanders have a personal apprehension in the matter, and believe that the Moon rummages their houses for skins or victuals, and destroys those persons who have not observed due sobriety. The South American Chiquitos try to help the darkened star against a dog that has worried it till its light has been colored red, and extinguished by its streaming blood; and they shoot arrows into the sky to drive away the dog. Charlevoix gives a similar account of the Guarani, except that with them a tiger takes the place of the dog; and in the language of the Tupis the literal translation of the word for an eclipse is, "The jaguar has eaten the sun." So, in Asia, the Tunguses believe an evil spirit has swallowed the earth's satellites, and they try to frighten it away by shots at the darkened disk. In Sumatra and Malacca the fear is aroused that a great snake will swallow the sun or the moon; and the Nagas of Assam set up a great drum-beating, as if in battle, to frighten away the devouring monster. Among the American tribes are some who believe that eclipses are a warning of the approaching disappearance of the sun and the fall of the moon at the end of the world. The Pottawattamies tell of a demon in the shape of an old woman, sitting in the moon weaving a basket, on the completion of which the world will be destroyed. A dog contends with the woman, tearing the basket to pieces every once in a while, and then an eclipse of the moon takes place; others imagine that the Moon is hungry, sick, or dying at these times; while the Alfuras of Ceram think he is asleep, and make a great uproar to awake him.

These superstitions are not so remote as they may seem at first sight from the impressions which the heavenly phenomena make upon many persons who consider themselves civilized. Circles may be found in nearly every nation upon whom the appearance of anything unusual in the sky carries an apprehension that something dreadful is about to happen; and by whom even the most ordinary phenomena are invested with occult influence upon things that we know have no connection with them; and it is only two or three centuries since the dire portents of comets and eclipses were prayed against in all the churches. In strange contrast with the impressiveness of the peoples whose names we have mentioned so often, and with the lingering European superstitions, stands the indifference of the stolid African tribes mentioned by Cameron and Paul Richard, who paid no attention to the eclipse, or thought it was only caused by passing clouds.—*Translated for the Popular Science Monthly from Das Ausland.*

SORGHUM AS A SOURCE OF SUGAR.

By HENRY B. PARSONS.

THE important part which sugar plays in our national and domestic affairs is, probably, not fully appreciated, except by those who have given the subject special study. Accustomed as we have become to hearing of the enormous output of our mines, it is at first somewhat difficult to realize that, in 1881, the people of the United States paid for foreign sugar, and imposts thereon, over fifty-seven million dollars more than the value of all the gold and silver bullion produced in the same year.

In the year 1882 our imports of sugar and molasses amounted to nearly one and one fifth million tons, costing one hundred and fifty million dollars, nearly one third of which sum was paid as import taxes. There is no other article, or class of articles, upon which our Government levies duty which yields a revenue equal to that obtained from foreign sugar.

This useful staple furnishes nearly one fourth (24·3 per cent) of the amount received for import duties, and more than one seventh (14·6 per cent) of the total income of the nation.

That the demand for sugar is increasing much more rapidly than our population, is shown by the increased consumption per capita. The value of the sugar used in 1882 was fully one sixth greater than the amount in 1881. In 1790 to 1799 the average annual consumption of sugar per person was 9·65 pounds, while in 1882 the amount was not far from fifty-five pounds.

In order to obtain the sugar that we need, we find it necessary to buy of nearly every tropical and sub-tropical country. By far the greatest amount (forty per cent) comes from Cuba. Next in order are the Spanish possessions (three and a half per cent), Porto Rico (two and a half per cent), the Sandwich Islands and the Dutch East Indies (each one per cent), while twenty-seven other countries unite to furnish nearly forty per cent. It will be seen that there remains only about twelve per cent for home production. This is strictly true, for, to quote a recent authority, "From the statistics it appears that, during the past twenty years, the United States have produced less than thirteen per cent of their sugar-supply, and little more than twenty-one per cent of the molasses consumed."

If, therefore, our Cuban sugar-supply were suddenly arrested by insurrection or international complications, we might for a season be in an exceedingly embarrassing position. Possibly some other country would ultimately come to our relief; but it is very probable that, for a time, there would be a scarcity of sugar, which would result in unusually high prices. Such a condition of things would surely direct the thoughts of consumers and capitalists alike to our very inadequate provisions for the manufacture of sugar in Louisiana and adjacent Southern States, and the fact would be evident that we could not extend the domestic production of sugar from the cane to approximate our demands. The reason lies in the fact that the sugar-cane is essentially a tropical plant, and is seldom or never thoroughly ripened in our semi-tropical Southern States. Early frosts compel the planters to harvest the canes while yet considerably short of maturity, and consequently before the development of as large a percentage of sugar as is reached in warmer climates.

This climatic disadvantage is so serious as to confine the profitable manufacture of sugar from the sugar-cane, in this country, to a very limited area, and to especially favorable seasons. This fact is emphasized and proved by reference to statistics which show that the amount of sugar produced in Louisiana in one year is frequently nearly twice as great as that obtained the next season.

Obviously, if it is desirable to produce our own sugar, the tropical sugar-cane can not be regarded as the chief source of supply, and we must place our dependence upon some plant better adapted to our varied soils and limited rainfall.

The sugar-beet has much to commend it; it is successfully raised in France, Germany, and Austria, and furnishes, at the present time, thirty per cent of the sugar consumed by civilized nations. But the sugar-beet requires special soil, special fertilizers, skillful cultivation, and, above all, an abundance of rain, which must come at just the right time to be of the greatest service. These conditions are well understood in Europe, and the tracts of country where beets may be profitably grown for sugar are known as "beet-sugar belts" upon the agricultural maps. Investigation has shown that the American beet-sugar belt is confined to a comparatively small portion of certain Northern and Middle States. It is possible that an important fraction of our sugar may yet be obtained from this source; but it is doubtful whether we should entertain hopes that this may ever be our chief dependence.

If, then, this country is to produce its own sugar, it is evident that some plant must be selected which, in one or more varieties, is adapted to our widely varied conditions. It must mature in the temperate Northern States as well as in the more genial climate of Southern California and the States bordering on the Gulf of Mexico. It must be easily cultivated—a plant of rapid growth, which, when mature, does not deteriorate until the season of severe frosts, thus insuring a long "working period," in which it may be converted into marketable sugar and molasses. Above all, it must furnish a juice rich in sugar, while containing a minimum of impurities.

It is claimed, by those who have given this sugar problem a very considerable amount of study, that in the better varieties of sorghum many or all of the above conditions are satisfied, and that, with intelligent culture and manufacturing methods, this country may not only produce all its own sugar, but may do its share toward supplying the ever-increasing demand abroad. These claims, if well supported, are deserving of careful study by all who desire to see the agricultural and manufacturing resources of this country more fully developed than at present.

The sorghum-plant (*Sorghum saccharatum*) belongs to the great family of grasses (*Graminaceæ*), and it may be termed a second-cousin to the tropical sugar-cane (*Saccharum officinarum*) on the one hand, and ordinary Indian corn (*Zea mays*) on the other. In some of its varieties it looks not unlike broom-corn (*Sorghum vulgare*), to which it is also related.

There are many modifications, or so-called "sub-varieties," of sorghum, which differ greatly in height, size, weight, and general appearance. Some varieties mature in Minnesota in about one hundred days from planting (as the Early Amber), while other varieties are only ripened to perfection in the Southern States (as the Honduras). Although there are more than one hundred real or imaginary "sub-varieties" of sorghum within the limits of the United States, it is probably safe to say that the question of profitable sugar-production may be determined from experiments made with a few typical varieties, originally known as Chinese and African.

The first Chinese sorghum was imported into this country in 1853, from the noted house of Vilmorin, in France. In 1857 the African varieties, some sixteen in number, were brought to this country from Natal by an English merchant, named Leonard Wray. "To these African varieties the general name imphees was given, while to the variety from China the name Chinese sugar-cane was given." So-called hybrids have been extensively advertised, yet the weight of evidence is against hybridization of the different sorghums, and the new varieties are probably the products of mixed seed.

During the progress of the civil war, sorghum played no unimportant part in helping to supply a portion of the deficiency in our imports of sugar. In many of the Western States, notably Ohio and Illinois, great amounts of sorghum-molasses were made by the farmers with crude and inexpensive apparatus. Usually the sirup had a peculiar, sharp taste, due to imperfect purification of the juice, the use of lime for this purpose not being generally understood. As a rule, also, the canes were crushed while still unripe, and consequently not containing the maximum amount of sugar. In spite of these unfavorable conditions, the reports that sugar had crystallized from these sirups were not infrequent.

At the close of the war many who had made sorghum-sirup again preferred to buy foreign sugar and molasses. The introduction of glucose-sirups may also have been instrumental in diverting attention from sorghum, and, for ten or more years, comparatively little was heard of the new sugar-plant.

About the year 1876 it was again brought into public notice through very favorable results, obtained by farmers in the Northwestern States, in the production of sirup from the variety known as Minnesota Early Amber.

So many and frequent were the requests that this plant be investigated, that General William G. Le Duc, a Minnesota man, upon his accession to the office of Commissioner of Agriculture, in 1877, determined that the possibilities of this sugar-plant should be accurately ascertained for the benefit of all who were concerned.

Accordingly, in 1878, the work was commenced by Professor Peter Collier, Chemist of the Agricultural Department, at Washington, and his investigations were continued through the years 1879 to 1882, inclusive.

One of the principal objects of this work was the determination of the precise quality of sorghum-juices at different periods in the development of the plant, in order to show at what stage the greatest amount of available sugar was present in the juice. It was shown, by thousands of analyses, that fully-matured plants yielded the greatest amount of sugar, and that the period during which this amount was maintained was full three months for some of the varieties which matured most rapidly.

It was shown that some kinds of sorghum matured quickly, and were well adapted to the short, hot summer season of the Northern States, while other varieties ripened more slowly, and were best adapted for cultivation in the Southern States.

It was demonstrated also that, when mature, the best of the different varieties were practically identical as regards the percentage of available sugar in the juice.

The amount of crystallizable sugar in the juice of mature sorghum varies between fourteen and sixteen per cent; there are also present about one to two per cent of uncrystallizable sugar ("glucose"), and two to three per cent of other solids, part of which are removed from the juice by the purifying processes employed in sugar-making. When well purified, sorghum, cane, and beet sugar are identical in composition and properties.

Among other valuable data obtained during these investigations, were recorded the length of time, after seeding, before the plant reached maturity; the length of the period during which the juice contained a profitable amount of available sugar (i. e., the "working period"); the height, weight, and percentage of juice for the stalks of each variety of sorghum at each stage in its development; and numerous other facts of importance to the practical sugar-maker.

The utilization of waste, or by-products, was carefully considered. It was shown that sorghum-seed is very similar in composition and food-value to common Indian corn, and that the yield of twenty or more bushels per acre will nearly or quite repay the farmer the cost of cultivation. This seed has been successfully used for fattening cattle and swine.

It was shown that the apparently worthless skimmings obtained in the clarification of the juice had a value as fertilizing material, and that from the washings of the tanks and evaporators a considerable amount of pure alcohol or vinegar could be produced at small cost.

The crushed canes ("begasse"), after the removal of the juice, make paper-stock of excellent quality and medium length of fiber. This begasse may be preserved as food for cattle by the method known as ensilage, or may be burned under the boilers, thus furnishing heat, and ashes valuable for fertilizing purposes.

But of greater value were the practical results obtained by Dr. Collier, with small and inexpensive apparatus, whereby he showed what could actually be done in the production of sugar and sirup from sorghum. These results were of more real importance than were the pretentious attempts made in Washington under the direction of a "practical sugar-boiler" from the West Indies, inasmuch as the latter experiments were made with improper and poorly-finished apparatus, and with sorghum not fully matured.

These experiments were also vitiated by the incompetence of the sugar-boiler, whose methods were those adapted to sugar-cane, and not varied to suit the different conditions presented when working with sorghum.

The smaller practical experiments conducted by Dr. Collier have been described in detail by himself, and, with perfect fairness, he has narrated not only successes but failures. All who are accustomed to manufacturing operations are aware that, notwithstanding the apparent simplicity of any new problem, the development of a practical working process involves a large amount of patient investigation, frequent experiments, and a not inconsiderable number of partial or seeming failures before complete success can be attained. But when such a process is thoroughly elaborated, and all its difficulties are appreciated and overcome, the details of manufacture may be safely intrusted to men of ordinary intelligence.

In November, 1881, the National Academy of Sciences appointed a special committee which was intrusted with a detailed investigation of the scientific processes, the analytical results, and the practical experiments and conclusions presented by Professor Collier.

All the members of this committee were men of the highest scientific ability, men whose reputation is world-wide, and whose conclusions must carry conviction. To quote from a recent number of "Science": "That the work has been well done is sufficiently guaranteed by the names of the committee. They were Professor William H. Brewer, Ph. D., of the Sheffield Scientific School; Professor Charles F. Chandler, of Columbia College; Professor S. W. Johnson, M. A., of the Sheffield Scientific School; Professor B. Silliman, M. A., M. D., of Yale College; Professor J. Lawrence Smith, M. D., late of the University of Louisville; and also, not of the Academy, Gideon E. Moore, Ph. D., of New York. Professor C. A. Goessmann, of the Massachusetts Agricultural College, was also a member of and acted with the committee until September 15, 1882, when he resigned."

The fairness and ability of the committee being unquestioned, it is germane, in this inquiry, to consider what their scrutiny of Dr. Collier's work has revealed as to the chances that sorghum may yet prove a valuable source of sugar. The following is taken from their report:

The spirit of scientific investigation which has led the Department of Agriculture through its chemical and agronomic researches to results of such importance toward developing a new industry of national value has been liberally fostered by the General Government, and to some extent also by certain of the States. The fruits of this policy are already beginning to show themselves in the decided success which has attended the production of sugar from sorghum on a commercial scale in the few cases in which the rules of good practice, evolved especially by the researches made at the laboratory of the Department of Agriculture, have been intelligently followed. Sufficiently full returns from the crop of 1882 have already come to hand to convince us that the industry is probably destined to be a commercial success.

The opinions of men so conservative as are the members of this committee can not be lightly set aside or ridiculed as visionary. That their predictions have, in a measure, been realized, will appear from the returns from the crop of 1883. From a recent work upon sorghum, by Professor Peter Collier, we extract the following:

Sorghum-Sugar produced in 1883.

According to the statement of the President of the Mississippi Valley Cane-Growers' Association, there were produced at the Champaign (Illinois) Sorghum-Sugar Works, from 145 acres, 1,435 tons of cane; and from 2,400 tons of cane there were obtained 160,000 pounds of sugar and 40,000 gallons of molasses.

The season is described as being the most unfavorable for thirty years.

At Hutchinson, Kansas, some 200,000 pounds of sugar, besides a large quantity of molasses.

At Sterling, Kansas, some 200,000 pounds of sugar, besides the molasses.

At Dundee, Kansas, 10,000 pounds of sugar, though their product was mainly sirup, of which 50,000 gallons were made.

At Kinsley, Kansas, 10,000 pounds of sugar, and a large quantity of sirup.

At Lawrence, Kansas, some 10,000 pounds of sugar.

At Rio Grande, New Jersey, 282,711 pounds of sugar and 55,000 gallons of molasses—a large portion of their cane failing to ripen, owing to the unusual season.

The Secretary of the Kansas State Board of Agriculture reports the following summary of the year 1883 for Kansas:

Acres planted in sorghum	102,042
Acres manufactured into sirup	48,271
Acres planted for forage	53,771
Tons of cane manufactured	447,859
Gallons of sirup made	4,684,023
Value of sirup made	$2,058,127 60

The entire number of counties reporting was eighty-one, and of these—

32	grew from	50 to 500	acres.
20	"	500 to 1,000	"
10	"	1,000 to 2,000	"
10	"	2,000 to 3,000	"
5	"	3,000 to 4,000	"
4	"	4,000 to 8,000	"

Ten counties produced over 100,000 gallons of sirup each, and two counties produced over $100,000 worth of sirup each, while seventeen counties produced each over $30,000 worth of sirup.

The value of sirup averaged from each acre $42.65, without counting the product of seed. The yield averaged 9·3 tons of cane per acre.

For the first years of a new industry such returns can not be considered other than decidedly promising. That the probabilities are strongly in favor of the ultimate success of sorghum as a source of sugar can hardly be doubted; but that the growth of such a vast industry must be gradual, and may at times be checked by the failures of untrained experimenters, is to be expected. It should be borne in mind, however, that one successful trial, resulting in the production of sugar in paying amounts, is of more value in estimating the possibilities of this new industry than are many failures. The development of any great industry is necessarily slow; especially is this true when manufacturers are not guided by previous experience with closely-related crude materials. The perfection of the manufacturing processes for beet-sugar is an illustration of this point.

It may be interesting, in this connection, to trace briefly the history of beet-sugar in France.

In 1747 Margraff presented a memoir to the Berlin Academy of Sciences, describing the methods whereby he had prepared sugar from beets, and urging the importance of his discovery. Little came of this investigation until half a century had elapsed, when Karl Franz Achard, a former pupil of Margraff, again drew attention to the matter. In 1799 he read a paper before the Institute of France, in which he described his methods and results. He exhibited samples of beet-sugar, and made such an impression that the French Institute appointed a commission, consisting of eminent men of science, to repeat Achard's work. They found about six per cent of sugar in beets, and thought that refined sugar could be produced for about eighteen cents per pound, or for less, if improved manufacturing methods were adopted.

MM. Barruel and Isnard were the first to produce beet-sugar on the commercial scale; they obtained only one and a half per cent of inferior sugar, at a cost of thirty cents per pound.

In 1811 M. Drappiez, of Lille, made beet-sugar at a cost of eighty cents a pound. Even this result, which would seem a disastrous failure to most observers, was sufficiently encouraging to justify the famous decree of Napoleon "that 32,000 hectares (79,040 acres) shall be planted in beets; that six experimental schools to give instruction in the manufacture of beet-sugar shall be established, and that 1,000,000 francs [$200,000] shall be appropriated from the budgets for this purpose, and for the experiments in producing indigo." "The importation of sugar and indigo from England and her colonies was prohibited."

With the aid of this liberal appropriation, and of numerous substantial gratuities to individuals, the development of this industry was still slow. In 1826 only 1,500 tons of beet-sugar were produced in France, but after that time the increase was more rapid, and we find France producing 420,396 tons of beet-sugar in 1879.

From small and inauspicious beginnings the beet-sugar industry has slowly grown, until it is securely established in France, Belgium, Austria, and Germany. At present, three eighths of the sugar used by civilized nations is produced by the sugar-beet. In like manner, the production of sugar from sorghum may not attain great proportions until some years have passed, but the plant is richer in sugar and is much more easily cultivated and handled than is the sugar-beet. The production of sorghum-sugar at a profit is less problematical than was the successful manufacture of beet-sugar when Napoleon issued the decree which laid the foundations of the beet-sugar industry in France.

The results of recent investigations of sorghum in the hands of other experimenters, as well as the immense amount of work done at Washington, have been rendered available, for the general reader and those interested in scientific and practical details, by a recent book written by Dr. Collier.* In this work, of over five hundred pages, a great number of scientific and economic problems are discussed, and our present definite knowledge of various points, formerly disputed, is clearly stated. The chemical changes occurring in the plant during its development have been recorded with an exactness suited to delight the student of vegetable physiology, while the practical sugar-maker need not look in vain for the latest information as to machinery and manufacturing processes. Farmers wishing to grow sorghum are told what varieties are most likely to succeed in Northern and what other varieties in Southern latitudes, and the best methods of planting, fertilizing, and securing the crop are carefully described.

In fact, this work has been well done, and its completeness is creditable alike to the thoroughness and the ability of the author. It is fortunate for this industry and for the country that these investigations have been prosecuted by a chemist so competent, and it is to be hoped that Congress may see fit to continue this work under the direction of Dr. Collier.

In view of the fact that the special committee of the National Academy has reported as its opinion, based on facts thus far presented, that the production of sugar from sorghum is likely to prove a commercial success, this country can well afford to expend liberal amounts of money for a continuation of these investigations, and for a practical demonstration of the cost of manufacturing sugar on the large scale.

* "Sorghum: Its Cultivation and Manufacture economically considered as a Source of Sugar, Sirup, and Fodder." By Peter Collier, Ph. D., late Chemist of the United States Department of Agriculture, Washington, D. C. Cincinnati: Robert Clarke & Co.

If, as a result of several seasons' practical operations, it shall be clearly shown that sugar can be profitably made from sorghum, an industry will speedily be established which will furnish employment for much labor and capital, and will add large sums to the wealth of this nation.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXXIV.

RESPECTING the *rationale* of the change that takes place in reheating stale bread, thereby renewing it and making it appear moist by actually driving away some of its moisture, the results of my investigations are as follow:

I find that, as bread becomes stale, its porosity *appears* to increase, and that, when renewed by reheating, it returns to its original *apparently* smaller degree of porosity. That this change can be only apparent is evident from the facts that the total quantity of solid material in the loaf remains the same, and its total dimensions are retained more or less completely by the rigidity of the crust. I say "more or less," because this depends upon the thickness and hardness of the crust, and also upon the completeness of its surrounding. Lightly-baked loaves shrink a little in dimensions in becoming stale, and partly regain the loss on reheating, but this difference only exaggerates the apparent paradox of varying porosity, as the diminished bulk of a given quantity of material displays increased porosity, and the increase of total dimensions accompanies the diminished porosity.

A reconciliation of this paradox may be obtained by careful examination of the structure of the crumb. This will show that the larger or decidedly visible pores are cells having walls of somewhat silky appearance. This silky luster and structure is, I have no doubt, due to a varnish of dextrin, the gummy nature of which I have already described. Now look a little more closely at this inner surface of the big blow-holes with the aid of a hand-lens of moderate power. It is not a continuous varnish of gum, but a net-work or agglomeration of gummy fibers and particles, barely touching each other.

My theory of the change that takes place as the bread becomes stale is that these fibers and particles gradually approach each other either by shrinkage or adhesive attraction, and thus consolidate and harden the walls of each of the millions of visible pores, i. e., the solid material of which the loaf is made up. In doing so they naturally increase the dimensions of these visible pores, while the invisible interstices or spaces between the minute fibers of the cell-walls are diminished by the approximation or adhesion of these fibers to each other.

This adhesion is probably aided by an oozing out or efflorescence of the vapor held by the fibers, and its condensation on their surfaces. This point, be it understood, is merely hypothetical, as the efflorescence is not visible.

When the stale bread is again heated, a general expansion occurs by the conversion of liquid water into aqueous vapor, every grain of water thus converted expanding to seventeen hundred times its former bulk. As this happens throughout, i. e., upon the surface of every one of the countless fibers or particles, there must be a general elbowing in the crowd, breaking up the recent adhesion between these fibers and drawing them all apart in the directions of least resistance, i. e., toward the open spaces of the larger and visible pores, producing that *apparent* diminution of porosity that I have observed as the visible characteristic of the change.

This explanation of the change may be further demonstrated by cutting a loaf through the middle from top to bottom, and exposing the cut surfaces. In this case the bread becomes unequally stale, more so near the cut surface than within. The unequal pull due to the greater adhesive approximation of the fibers and small particles causes a rupture of the exposed surface of the crumb, which becomes cracked or fissured without any perceptible alteration of the size of the visible pores. If the two broken faces be now accurately placed together, the halves thus closely joined, firmly tied together, and placed for an hour in the oven, it will be seen on separating them that the chasms are considerably closed, though not quite healed. Careful examination of the structure of the inside, by breaking out a portion of the crumb, will reveal that loosening of the structure which I have described.

I should add that, in quoting the figures given by Boussingault in my last, I inadvertently omitted to reduce them from the French to the English thermometric scale: 130° to 150° centigrade is equal to 266° to 302° Fahr., which is considerably below the temperature required for starting the original baking.

"Popped corn" is a peculiar example of starch-cookery. Here a certain degree of porosity is given to an originally close-compacted structure of starch by the simple operation of explosive violence due to the sudden conversion into vapor of the water naturally associated with the starch. The operation is too rapid for the production of much dextrin.

As most of my readers doubtless know, peas, beans, lentils, and other seeds of leguminous plants are more nutritious, theoretically, than the seeds of grasses, such as wheat, barley, oats, maize, etc. I was glad to see at the Health Exhibition a fine series of the South Kensington cases displaying in the simplest and most demonstrative manner the proximate analyses of the chief materials of animal and vegetable food. I refer to them now because they do not receive the attention they deserve. On the opening day there was, out of all the crowd, only one other besides myself bestowing any attention upon them. I soon learned in conversation with him that he is a reader of "Knowledge." These cases show one pound of wheat, oats, potatoes, peas, etc., etc., on trays; by the side of these are bottles, containing the quantity of water in the one pound, and other trays, with the other constituents of the same quantity, the starch, gluten, casein, the mineral matter, etc., thus displaying at a glance the nutritive value of each so far as chemical analysis can display it. Those Irishmen and others, who think I have been too hard upon the potato, will do well to take its nutritive measure thus, and compare it with that of other vegetable foods.

They will see that all the leguminous seeds, the ground-nuts, etc., have their nitrogenous constituents displayed under the name of "casein." The use of this term is rather confusing. In many modern books it does not appear at all in connection with the vegetable kingdom, but is replaced by "legumin." Liebig regarded this nitrogenous constituent of the leguminous seeds, almonds, etc., as identical with the casein of milk, and it was a pupil and friend of Liebig's—the late prince consort—who devised and originally supervised this graphic method of displaying the chemistry of food.*

I will not here discuss the vexed question of whether the analyses of Liebig, identifying legumin with casein, or rather those of Dumas and Cahours, who state that the vegetable casein is not of the same composition as animal casein, are correct.

The following figures display my justification for thus lightly treating the discussion:

	Casein.	Legumin.	Legumin.	Legumin.
Carbon	53·7	50·50	55·05	56·24
Hydrogen	7·2	6·78	7·59	7·97
Nitrogen	16·6	18·17	15·89	15·83
Oxygen, Sulphur	22·5	24·55	21·47	19·96

The first column shows the results of Dumas for animal casein; the second those of Dumas and Cahours for legumin; the third those of Jones for the same; and the fourth those of Rochleder; all as quoted by Lehmann. Here it will be seen that the differences upon which Dumas and Cahours base their supposed refutation of the identity of the animal with the vegetable principle are much smaller than the differences betwen the results of different analyses of the latter. These

* Shortly after the close of the Great Exhibition of 1851, when the South Kensington Museum was only in embryo, I had occasion to call at the "boilers," and there found the prince hard at work giving instructions for the arrangement and labeling of these analyzed food-products and the similarly displayed materials of industry, such as whalebone, ivory, etc. I then, by inquiry, learned how much time and labor he was devoting, not only to the general business of the collection, but also to its minor details.

differences, I suspect, are all due to the difficulty of isolating the substances in question, especially of the vegetable substance, which is so intimately mixed with the starch, etc., in its natural condition that complete separation is of questionable possibility.

This will be understood by the following description of the method of separation as given by Miller ("Elements of Chemistry," Vol. III): "Legumin is usually extracted from peas or from almonds, by digesting the pulp of the crushed seeds in warm water for two or three hours. The undissolved portion is strained off by means of linen, and the turbid liquid allowed to deposit the starch which it holds in suspension; it is then filtered and mixed with dilute acetic acid. A white flocculent precipitate is thus formed, which must be collected on a filter and washed."

This is but a mechanical process, and its liability to variation in result will be learned by anybody who will repeat it, or who has separated the gluten of flour by similar treatment.

Practically regarded in relation to our present subject, casein and legumin may be considered as the same. Their nutritive values are equal and exceptionally high, supposing they can be digested and assimilated. One is the most difficult of digestion of all the nutritive constituents of vegetable food, and the other enjoys the same distinction among those of animal food. Both primarily exist in a soluble form; both are rendered solid and insoluble in water by the action of acids; *both are precipitated as a curd by rennet*, and both are rendered soluble after precipitation or are retained in their original soluble form by the action of alkalies. They nearly resemble *in flavor*, and John Chinaman makes actual cheese from peas and beans.

These facts, coupled with what I have already said concerning cheese and its cookery, will doubtless lead my readers to expect something concerning pease-pudding and potash in my next.

XXXV.

"Pease-pudding hot, pease-pudding cold,
Pease-pudding in the pot, nine days old."

I leave to Mr. Clodd the historical problem of determining whether this notable couplet is of Semitic, Aryan, Neolithic, or Palæolithic origin. Regarded from my point of view it expresses a culinary and chemical principle of some importance, and indicates an ancient practice that is worthy of revival.

I have lately made some experiments on the ensilage of human food, whereby the cellular tissue of the vegetable may be gradually subjected to that breaking up of fiber described in No. 28. One of the curious achievements of chemical metamorphoses that is often quoted as a matter for wonderment is that of converting old rags into sugar by treating them with acid. The wonderment of this is diminished, and its interest increased, when we remember that the cellulose or woody fiber of which the rags are composed has the same composition as starch, and thus its conversion into sugar corresponds to the every-day proceedings described in No. 30. All that I have read and seen in connection with the recent ensilage experiments on cattle-fodder indicates that it is a process of slow vegetable cookery, a digesting or maceration of fibrous vegetables in their own juices which loosens the fiber, renders it softer and more digestible, and not only does this, but, to some extent, converts it into dextrin and sugar.

I hereby recommend those gentlemen who have ensilage-pits and are sufficiently enterprising to try bold experiments, to water the fodder, as it is being packed down, with dilute hydrochloric acid or acetic acid, which, if I am not deluded by plausible theory, will materially increase the sugar-forming action of the ensilage. The acid, if not over-supplied, will find ammonia and other bases with which to neutralize itself.

Such ensilage will correspond to that which occurs when we gather Jersey or other superlatively fine pears in autumn as soon as they are full grown. They are then hard, woody, and acid, quite unfit for food, but by simply storing them for a month, or two, or three, they become lusciously soft and sweet, the woody fibers are converted into sugar, the acid neutralized, and all this by simply fulfilling the conditions of ensilage, viz., close packing of the fiber, exclusion of air by the thick rind of the fruit, *plus* the other condition which I have just suggested, viz., the diffusion of acid among the well-packed fibers of the ensilage material.

In my experiments on the ensilage of human food I have encountered the same difficulty as that which has troubled graziers in their experiments, viz., that small-scale results do not fairly represent those obtained with large quantities. There is, besides this, another element of imperfection in my experiments respecting which I am bound to be candid to my readers, viz., that the idea of thus extending the principle was suggested in the course of writing this series, and, therefore, a sufficient time has not yet elapsed to enable me (with much other occupation) to do practical justice to the investigation.

I find that oatmeal-porridge is greatly improved by being made some days before it is required, then stored in a closed jar, brought forth and heated for use. The change effected is just that which theoretically may be expected, viz., a softening of the fibrous material, and a sweetening due to the formation of sugar. This sweetening I observed many years ago in some gruel that was partly eaten one night and left standing until next morning, when I thought it tasted sweeter, but, to be assured of this, I had it warmed again two nights afterward, so that it might be tasted under the same conditions of temperature, palate, etc., as at first. The sweetness was still more distinct, but the experiment was carried no further.

I have lately learned that my ensilage notion is not absolutely new.

A friend who read my Cantor lectures tells me that he has long been accustomed to have seven dishes of porridge in his larder, corresponding to the days of the week, so that next Monday's breakfast was cooked the Monday before, and so on, each being warmed again on the day fixed for its final execution, and each being thus seven days old. He finds the result more digestible than newly-made porridge. The classical nine days' old pease-pudding is a similar anticipation, and I find, rather curiously, that nine days is about the limit to which it may be practically kept before mildew—moldiness—is sufficiently established to spoil the pudding. I have not yet tried a barrel full of pease-pudding or moistened pease-meal, closely covered and powerfully pressed down, but hope to do so.

Besides these we have a notable example of ensilage in sour-kraut —a foreign luxury that John Bull, with his usual blindness, denounces, as a matter of course. "Horrid stuff," "beastly mess," and such-like expressions, I hear whenever I name it to certain persons. Who are these persons? Simply Englishmen and Englishwomen who have never seen, never tasted, and know nothing whatever of what they denounce so violently, in spite of the fact that it is a staple article of food among millions of highly-intelligent people. Common sense (to say nothing of that highest result of true scientific training, the faculty of suspending judgment until the arrival of knowledge) should suggest that some degree of investigation should precede the denunciation.

In the cases of the sour-kraut and the ripening pear there is acid at work upon the fiber, which, as I have before stated, assists in the conversion of such indigestible fiber into soluble and digestible dextrin and sugar; but the demand for the solution of the vegetable casein or legumin, which has such high nutritive value and is so abundant in peas, etc., is of the opposite kind. Acids solidify and harden casein, alkalies soften and dissolve it. Therefore the chemical agent suggested as a suitable aid in the ensilage or slow cookery, or the boiling or rapid cookery, of leguminous food is such an alkali as may be wholesome and compatible with the demands for nutrition.

Now, the analyses of peas, beans, and lentils, etc., show a deficiency of potash salts as compared with the quantity of nitrogenous nutriment they contain; therefore I propose, as in the case of cheese-food, that we should add this potash in the convenient and safe form of bicarbonate, not merely add it to the water in which the vegetables may be boiled, and which water is thrown away (as in the common practice of adding soda when boiling greens), but add the potash to the actual pease-porridge, pease-pudding, lentil-soup, etc., and treat it as a part of the food as well as an adjunct to the cookery. This is especially required when we use dried peas, dried beans of any kind, such as haricots, dried lentils, etc.

I find that taking the ordinary yellow split-peas and boiling them in a weak solution of bicarbonate of potash for two or three hours, a partial solution of the casein is effected, producing pease-pudding, or pease-porridge, or *purée* (according to the quantity of water used), which is softer and more gelid than that which is obtained by similarly boiling without the potash. The undissolved portion evidently consists of the fibrous tissue of the peas, the gelatinous or dissolved portion being the starch, with more or less of casein. I say "more or less," because, at present, I have not been able to determine whether or not the casein is all rendered soluble. The flavor of the clear pea-soup, which I obtained by filtering through flannel, shows that some of the casein is dissolved; this is further demonstrated by adding an acid to the clear solution, which at once precipitates the dissolved casein. The filtered pea-soup sets to a stiff jelly on cooling, and promises to be a special food of some value, but, for the reasons above stated, I am not yet able to speak positively as to its practical value. The experience of any one person is not sufficient for this, the question being, not whether it contains nutritive material—this is unquestionable—but whether it is easily digested and assimilated. As we all know, a food of this kind may "agree" with some persons and not with others—i. e., it may be digested and assimilated with ease or with difficulty according to personal idiosyncrasies. The cheesy character of the abundant precipitate, which I obtain by acidulating this solution, is very interesting and instructive, regarded from a chemical point of view. The solubility of the casein is increased by soaking the peas for some hours, or, better still, a few days, in the solution of bicarbonate of potash.

Another question is opened by these experiments, viz.: What is the character and the value of the fibrous solid matter remaining behind after filtering out the clear pea-soup? Has the alkali acted in an opposite manner to the acid in the ripening pear? Is it merely a fibrous refuse only fit for pig-food, or is it deserving of further attention in the kitchen? Should it be treated with dilute acid—say a little vinegar—to break up the fiber, and thereby be made into good porridge? Other questions crop up here, as they have been cropping continually since I committed myself to the writing of these papers, and so abundantly that, if I could afford to set up a special laboratory, and endow it with a staff of assistants, there would be some years' work for myself and staff before I could answer them exhaustively, and doubtless the answers would suggest new questions, and so on *ad infinitum*. I state this in apology for the merely suggestive crudity of many of the ideas that I throw out in the course of these papers.

Before leaving the subject of peas, I must here repeat a practical suggestion that I published in "The Birmingham Journal" about twenty years ago, viz., that the water in which green peas are boiled should not be thrown away. It contains much of the saline constituents of the peas, some soluble casein, and has a fine flavor, the very essence of the peas. If to this, as it comes from the saucepan, be added a little stock, or some Liebig's extract, a delicious soup is at once produced, requiring nothing more than ordinary seasoning. With care, it may form a clear soup such as just now is in fashion among the fastidious; but, prepared however roughly, it is a very economical, wholesome, and appetizing soup, and costs a minimum of trouble.

I must here add a few words in advocacy of the further adoption in this country of the French practice of using, as *potage*, the water in which vegetables generally (excepting potatoes) have been boiled. When we boil cabbages, turnips, carrots, etc., we dissolve out of them a very large proportion of their saline constituents—salts which are absolutely necessary for the maintenance of health; salts, without which we become victims of gout, rheumatism, lumbago, neuralgia, gravel, and all the ills that human flesh, with a lithic-acid diathesis, is heir to, i. e., about the most painful series of all its inheritances. The potash of these salts existing therein, in combination with organic acids, is separated from these acids by organic combustion, and is then and there presented to the baneful lithic acid of the blood and tissues, the stony torture-particles of which it converts into soluble lithate of potash, and thus enables them to be carried out of the system.

I know not which of the fathers of the Church invented fast-days and *soup maigre*, but could almost suppose that he was a scientific monk, a profound alchemist, like Basil Valentine, who, in his seekings for the *aurum potabile*, the elixir of life, had learned the beneficent action of organic potash salts on the blood, and therefore used the authority of the Church to enforce their frequent use among the faithful.—*Knowledge.*

HYGIENE FOR SMOKERS.

BY DR. FÉLIX BREMONT.

THIS article is not intended for school-boys desiring to enjoy their cigarettes out of the sight of their tutor, nor for children who try to play the man by taking up one of his faults. It is addressed to smokers, but does not purpose to increase the number of them. Its design is to indicate what precautions may be taken to diminish as far as possible the inconveniences of smokers' glandular irritation; but it affirms the reality of these inconveniences, and declares it impossible to remove them completely.

The first hygienic principle relative to tobacco is, then, Do not smoke at all; don't smoke at any age. More than one old smoker will agree with me that it would have been good for him if he had never lit a cigar; for he suffers now if he can not smoke a half-dozen of them in the course of the day. The habit of smoking creates a factitious want that is, perhaps, more imperative than real wants, and which is a constant trouble to those who feel it. When I have a pressing engagement after dinner, I cut my meal short so as to have time to smoke a cigar; and there is to me nothing to suggest doubt in the story related by Philibert Audebrand of Father Schoëne, director of Louis Philippe's park of Monceaux, who loved two things—his plants and his pipe. From morning till night he lived in the garden, and from morning till night he carried a short pipe in his mouth, which he would not take out for any one. "It may pass before me," said Louis Philippe to him one day "but to smoke so in the presence of the queen and the princesses!" "Sire," replied Schoëne, "it is stronger than I am. If your majesty is not satisfied with my service, I shall have to present my account; I shall probably die with vexation over the matter, but it will be with my pipe between my teeth."

Do not enroll yourselves, then, beardless readers, in the battalions of Nicotia. Initiation into her mysteries has painful accompaniments, and her fervent worship brings troubles of another character. Tobacco is smoked in cigars, cigarettes, and pipes. Placed in contact with the mouth, the cigar, which can not escape some chewing, colors the saliva and charges it with the toxic principles of the tobacco—elements, principally nicotine, that should be carefully rejected. A person smoking only a simple light cigar may, perhaps, see the end of it without spitting, but, if he consumes any number of them, he must spit frequently. This exercise is less indispensable when a cigar-holder is used, and the adoption of such a mouth-piece is recommended by hygiene as a means of avoiding the direct contact of the mouth with the tobacco, and considerably diminishing the inconveniences of smoking. Cigar-holders are made of amber, shell, glass, bone, cherry, birch, lilac, jasmin, maple, and cane. Holders made from the last wood are the best, because they are generally longer than the others, whereby the smoke may become cooled, and because, being very cheap, they can be frequently renewed. Other inconveniences, involving questions of cleanliness, are avoided by the use of the cigar-holder. Too many hands touch the tobacco while it is being manufactured into a cigar for one to be able to say it has not been soiled, and cases of its having been the vehicle for conveying contagious disease are not unknown.

Havana cigars are the best, but how to get them? The coat does not make the monk, nor does the label make a real Havana. We read in the "Journal d'Hygiène" that cigars are bought at very cheap prices at various places in Europe, and then shipped to Havana, where they are boxed and labeled and sent back to Europe. According to M. Cardon, the matter is arranged more expeditiously at Hamburg and

Frankfort, where cabbage-leaf cigars are sold as real Havanas under the government stamp, which they have acquired the right to bear by being sent out to meet vessels coming in from Cuba, whose arrival in the Baltic or in the Channel has been signalized. The cigars go through the custom-house, get the government mark, and are worth ten times as much as they were before their little excursion. It is a good hygienic precaution to choose dry cigars. The nicotine, being volatile, gradually escapes during the drying process, and the smoker consequently absorbs less of it. The absorption is also less when the smoking is done slowly; but, if one smokes fresh cigars fast and without spitting, his mouth and nervous system become so saturated with the narcotic ingredients of the smoke that, according to Professor Johnston, every kind of pipe becomes insipid to him.

Tobacco rolled up in a thin, combustible substance, which is burned with it, forms a cigarette. Many doctors regard this as the most dangerous form in which tobacco can be smoked. Dr. Barré recently invited smokers of cigarettes, in the journal "Le Peuple Français," to observe if they did not, after having smoked ten or a dozen of them, feel a pressure on the left side, with palpitation of the heart. The more we advance in the practice of medicine, he added, and the more we question our fellow-doctors, "the more we are convinced that the abuse of the cigarette is one of the most frequent causes of diseases of the heart." As for myself, I have never observed the troubles noticed by Dr. Barré; but I have remarked others, particularly inflammatory angina and laryngitis. The irritation of the back part of the mouth and respiratory channels probably arises from the habit, common with smokers, of swallowing the smoke. This is a noxious practice, and must be avoided. In some countries cigarettes are rolled in corn or plantain leaves; in France, we roll them in paper. A great many persons think that the mischievous effects of the cigarette are due to this envelope. I owe it to the truth to say that the accusation has not been established. If the use of the cigarette is really more injurious than that of the cigar, it is probably because, in cigarette-smoking, we have to use tobacco that is more moist, and consequently more charged with nicotine. The question respecting the envelope is not yet solved. The makers of cigarette-paper certainly take great care to fill the public with the idea of danger attending the use of paper of bad quality. They all offer the smoker superior papers, of pure fiber. The more refined offer coal-tar paper, to prevent chest-irritation; ferruginous paper, as a guard against anæmia; and even pepsin-paper, to facilitate digestion. It is all smoked, and that is the end of it. Use any paper you please, gentlemen; the important thing for hygiene is, that you do not use too much. The same recommendation is addressed to the ladies—for there are ladies who smoke; the Society of Public Medicine was occupied with them in 1880. MM. Decaisne, Delaunay, Thévenot, Bouley, Brouardel, and Goyard said some very interesting things on the occasion; but, after a brilliant oratorical display, "richer in arguments than in observed facts," the society wisely concluded that "it was not necessary to conclude anything." That is my position on this vexed question of cigarette-paper.

Larouse says that, although it is admitted as a principle that only the cigar is in good taste in the street, the pipe is, in the privacy of home, the relaxation of persons in the highest social classes as well as of the masses. The observation is just. All great smokers use the pipe. The poor smoke a modest clay pipe; the rich a meerschaum set with silver and amber, carved and engraved like a precious stone; poor and rich, consuming much tobacco, burn it in an incombustible bowl with a tube attached; whatever it may be, it is still a pipe, and, if it costs more, it is no better than the cheaper one, but rather the contrary. If all pipes were equally durable, they might be classed, according to their merit, as follows: 1. Soft earthen pipe; 2. Meerschaum; 3. Hard earthen pipe, white or colored; 4. Wooden pipe; 5. Porcelain pipe; 6. Metallic pipe.

The white earthen pipe, porous and permeable to liquids, is put first, because it is a good absorber of nicotine; the metallic pipe is put last, because it allows all the noxious products formed during the combustion of the tobacco to reach the mouth of the smoker. The meerschaum, which immediately follows the clay pipe, deserves its place only on condition that it is not too old. If it is seasoned, it is as bad as a wooden or porcelain pipe. The seasoning, of which poets have sung, may be full of charms for the amateur; to the hygienist, it simply indicates that the pipe has had its day, and is now saturated with tobacco-juice; and that it must be replaced by another one, or be passed through the fire to purify it, as is done in the coffee-houses of Holland. Every old pipe, browned with long use, leaves on the lips and tongue an acrid and strong-smelling liquid which irritates the tissues and corrodes the mucous secretions. When it has reached this condition, the finest meerschaum is no better than the meanest scorch-throat. Independently of the substance, the form of the pipe has an influence on the proportion of noxious ingredients which tobacco-smoke contains. Turkish and Indian pipes, in which tobacco is burned slowly, discharging its smoke through a liquid, arrest a large proportion of the poisonous ingredients. The bowl of the German pipe retains the greater part of the oily products; the Dutch and English clay pipes retain less. The metallic pipes of Thibet, becoming heated, carry to the mouth not only brown liquids saturated with nicotine, but also a smoke hot enough to burn the tongue. The pipe should, then, be long, and, in order that the smoker may become convinced of this, I submit to him these lines by Dr. Buisson, taken from his article on "The Lips," in the "Dictionnaire Encyclopédique des Sciences Médicales": "It is not without reason that the popular tongue has energetically described by the name *brûle-gueule* (scorch-throat) the pipe with a short stem.

Not only is this stem impregnated with the empyreumatic matter with which old pipes become browned in seasoning, but it is heated to such a degree as to subject the lips to a local elevation of temperature, a kind of chronic burning, which causes a thickening of the epithelial layer in the same manner as the contact with hot bodies increases the epidermic secretion on the hands of subjects exercising certain professions." It should be added that every smoker should have his own pipe, and not use indifferently any one that comes to hand.

Whether we smoke a cigar, a cigarette, or a pipe, two hygienic precepts should not be lost sight of: The first relates to the atmosphere, and may be formulated—it is less injurious to smoke in the open air than in a room, in a large room than in a small one. Be careful, then, smokers, to ventilate liberally and frequently the apartments in which you smoke your tobacco. The second precept is a question of cleanliness. If it is good for every one to attend frequently to the washing of his mouth and teeth, the usefulness of the habit becomes a rigorous obligation to every one who is addicted to the pipe, the cigar, or the cigarette. A wet cloth passed over the gums and teeth in the morning may possibly be enough for persons who do not smoke, but the brush is indispensable for smokers. A simple gargle of aromatized warm water is better to neutralize the odor of tobacco than the best scented pellet.—*Translated for the Popular Science Monthly from the Journal d'Hygiène.*

HOW THE DODDER BECAME A PARASITE.

By JOSEPH F. JAMES.

OVER yonder in the corner of a field there grows a mass of yellow threads, looking at a distance like an immense spider's web covering a number of plants. Closer inspection reveals it to be the dodder, poetically called by some the golden-thread. Though beautiful in the abstract, handsome in its golden color, it is yet a vile and pernicious weed—one that in the flax-fields of Europe in one form, and in the alfalfa-fields of California in another, has done a vast deal of harm. Yet it is, to look at, beautiful. The flexuous stem of golden yellow, adorned with clusters of white, bell-shaped flowers, twining among and over other plants, forms a striking contrast with their green stems and leaves. And it is no wonder it has been sometimes cultivated for its beauty. Why, then, should we call it a pernicious weed? Look closer, and you will see that at intervals along the stem, where it clings closely to other plants, it has sent out bunches of little rootlets, which, not content with performing the office of hold-fasts, force their way through the bark, penetrate the tissue, and take the matter found there into their own systems.

Still closer examination will reveal other features. In the first place, there are none of the green leaves usually found on plants. Secondly, there is no root fastening the plant to the soil. Why is this? What is the reason that this plant grows and flourishes like other plants, and has yet neither root nor leaves? Let us see.

What is known as parasitism in plants is not confined to any one family or class. Various orders have one or more genera with species which take their nourishment in a complete or partly elaborated form from other plants. Sometimes they are perfect parasites, and take everything they need from other vegetable forms. Sometimes, as in the mistletoe, they take the partially made sap, and complete its transformation within their own tissue; while in still other instances only a very little of the sap is taken, and the other nourishment is absorbed from the soil by the roots proper.

Our dodder is an example of a perfect parasite. All the material necessary for its growth it takes ready made from the plants upon which it grows. As the purpose of leaves in all plants is to prepare from the crude materials in the air and soil the matter necessary for its growth, and as the dodder finds and appropriates this material already made, the absence of leaves is at once accounted for. There was no need for them, and they ceased to be.

The want of a root is another matter. When the seed of the dodder is examined, it is found that there is simply a coiled embryo, with very little albumen. The usual seed-leaves are absent; so that, for its first growth, it must depend entirely upon the albumen in the seed. When this seed first germinates, a little rootlet penetrates the ground. Owing to the deficiency of food, it only exists long enough to enable its stem to grow till it reaches some plant upon which it can fasten. When this is accomplished, the young plant will grow rapidly, and soon sever its connection with the ground; but, if not able to reach some support, it dies entirely.

In order to comprehend the reasons for the peculiarities of the dodder, and understand how it came to assume its habit of complete parasitism, it will be necessary to notice the probable rise and progress of the habit. We can do this by looking at some of those plants which are not yet such complete pensioners on the bounty of others. For it very seldom happens that all the steps leading from a normal to an out-of-the-way mode of living are lost. Some few will remain, to indicate the line along which the plant has proceeded. Imperfect adaptations point surely the path leading to perfect development.

The modes of living of the dodder and the Indian pipe may be considered as the two extremes of one line of development. The first is a complete parasite, and the second has gone so far as to become a saprophyte. The central point from which sprang the two branches is probably represented in certain species of *Gerardia.* Here is found the first indication of the parasitic habit. While the roots are attached to those of other plants, its green leaves are well developed, and it takes only the crude material into its system and there elaborates it; and at the same time it absorbs matter by means of the other roots with which it is provided.

The mistletoe comes second. In this plant we find the root absorbing nourishment from the branch on which it has located; the stem provided with green leaves, to which it can bring the sap to a proper state for assimilation, but no connection with the soil. The next step would be for the plant to loose its connection with earth or branch, take the fully elaborated sap, and by gradual stages lose all its foliage organs. Then the fully formed parasitic dodder results.

Proceeding in the opposite direction we find the beech-drop, a plant which lives in the rich mold of beech-woods, taking part of its food from the decaying leaves, and part from the roots of the beech-trees which it penetrates with its own rootlets. This plant is entirely destitute of green leaves, is of a brownish color, and may be considered one step on the road taken by the Indian pipe.

The Indian pipe, again, is a little plant which lives in the *dêbris* of forests, finding its food in the mass of decaying vegetable mold. While it is not probable that its roots are connected with those of the trees under which it grows, it is certain that the rich matter there found contains the constituents it requires for its growth. It, like the dodder, is destitute of green leaves, and for the same reason, namely, because it finds its food already prepared for it and has only to absorb it. But it differs in taking the food from the dead and decayed matter, instead of from the living. Plants of this kind are known as saprophytes, and are most common among the fungi. Here, then, in the saprophytic Indian pipe we have one end of a line of habit of living which has its other end in the perfect parasitism of the dodder.

In attempting to trace the origin of any particular habit peculiar to any one species, it is always necessary to examine the near relatives and see in what respects they resemble and in what ones they differ from the plant under consideration. The dodder belongs to the *Convolvulaceæ,* or the morning-glory family, and one of the most striking features of this family is found in their habits of twining. But what a vast difference there is in appearance between the morning-glory, with its large leaves, its root, and its conspicuous flowers, and the dodder, with its yellow stem, complete absence of green leaves, and lack of root! How is the change to arise which will bring the dodder to its present condition?

Evolutionists acknowledge that all changes in either plants or animals are the results of changes in conditions or surroundings. When once a change has occurred which is beneficial in a certain way, the probability is, that the plant or animal will continue to develop in that direction till it diverges widely from the original form. The struggle for existence will cause all the imperfect forms to be killed off, and only those will survive which are best suited to the altered conditions of life. Once let an organism begin to vary in any one direction, and there is no telling where or when it will stop. This much is certain, that it never ceases until the best results possible have been attained.

The chief characteristic, then, of the convolvulus family is the climbing habit. The origin of this habit is found in the fact that sunlight and air are two things needful for a plant's proper growth and development. In situations where these two things are found in limited quantities, plants with climbing habits and animals with arboreal instincts will abound. In Brazil, for instance, where immense tracts are covered with a dense forest-growth, it is noticed that all forms of animal life have become adapted to residence in trees. Many of them live there entirely. Monkeys seldom leave the tree-tops. Lizards and snakes and insects are there, and even man himself is often found living among the branches. So, too, plants form immensely long stems, reaching in many cases to the tops of trees a hundred feet high. The extraordinary development of climbing powers has been gradually acquired in the course of ages. In times and places where vegetation was not dense, and where the struggle for light was not great, plants of erect habit succeeded well. Then it was a conflict to see which could grow tallest. But when a weak plant found that, by taking hold of its tall and erect neighbor and by clinging to it, it could reach the sunlight much easier and by an expenditure of much less material than by growing erect itself, it was a great step on the road. This habit, being transmitted from one generation to the next, kept on improving. Less and less rigid, more and more flexuous stems ensued, and the delicate climbing vines of modern times are the results of this necessity of reaching sunlight with as little waste of material as possible.

There are many methods adopted by plants to climb. While some of them reach upward by means of tendrils developed at the ends of stems or leaves, others twist their petioles round the support, and still others twine their stems round other stems that may come in their way. This last is the method adopted by those of the *Convolvulaceæ* which climb at all. For even in this family there are some species which are erect in growth. The *Calystegia spithamæa* is one of them. Others do not grow up into the air, but trail along the ground or over low plants, and thus secure their due share of sunlight. Others, again, climb freely, and this is the case with the dodder.

The climbing bitter-sweet is said to sometimes strangle the trees upon which it grows. The constriction caused by its growing stem is so great as to cut off the supply of sap from the roots, and cause the death of the tree which has supported it. The original ancestor of the dodder was a plant with a well-developed root, green stem and leaves, and a twining habit. If its clasping killed the stem which supported it, the effect would be disastrous, for then it would not accomplish the purpose of its climbing. If the twining stem sank into the supporting one, it might cause decay along the line. This decaying would tend to develop rootlets from the side of the climber. The rootlets, used at first merely to assist in climbing, might and must have become modified so as to penetrate the bark to the tissue beneath. A minute absorption of the sap from this would be an assistance. Gradual increase of the amount absorbed would lead to gradual increase in the number of rootlets. And, this continuing, less and less need would be felt for the leaves. As needless organs are sure to degenerate, the leaves would become smaller and smaller, lose more and more of their green color, and finally become the yellow scales and bracts they now are.

Along with the loss of the leaves would go the root. Becoming less necessary, it would get smaller, until finally it would retain only enough of its original character to give the plantlet a start in life, and transmit its qualities to its progeny. Of course, all these changes would be made slowly; but they would come surely. If each succeeding generation of rooting stemmed plants throve better in any way, perfected seed in any greater abundance, or were enabled to crowd out competitors in the struggle for life, we may be sure that the descendants of the favored plants would inherit these good traits, and would send more and more rootlets into the enveloped stem, until at last the habit would become firmly fixed. Thus would be formed a leafless, rootless parasite, so well adapted to hold its own that it would probably exterminate some of the less favored forms.

The commencement of the habit of sending rootlets into stems has been observed in occasional specimens of the convolvulus. Let but this habit grow and be improved upon, as it surely will be if it is found beneficial, and from this small beginning we can look for just such a development as has been found in the dodder. It can not be said that there is always an upward progress in Nature. Degenerate forms exist and thrive as well as regenerate ones. The truth is, that when a plant or an animal can fill a vacant space in the world better by going backward than by going forward, the retreat is sounded. Progress or retrogression, it is the same. The direction best suited to Nature's needs is the one taken; so that, while on the one hand there may be a wonderfully complex organism, perfectly fitted for the struggle for life, on the other hand there may be a very degenerate one equally fitted into its place.

SUN-KINKS.

By T. O'CONOR SLOANE, Ph.D.

IN a recent journal of this city an article descriptive of a railroad accident appeared, under the heading, "Derailed by a Sun-Kink." The title doubtless puzzled many readers. The term indicates that the rails were thrown out of line by expansion, due to the heat of the sun. Few accidents are attributed to this cause, though it may be responsible for more than are supposed. It will be interesting to determine a few maxima of distortion that can be thus produced.

The expansion of metals under the influence of heat is very slight. A mile of iron rails, for an elevation of temperature of 100° Fahr., only expands two feet eight and one half inches. This is so little as to be readily taken up by the one hundred and seventy-six joints that exist in that length of rails. If the rails were laid in very cold weather, in solid contact with each other, then, on a warm, sunny day, a considerable disalignment could be produced. To find the maximum for the mile of rails, we must suppose that the line breaks in the middle, and bulges out like a flattened letter V. In this condition of things, the broken line of rail, with the original line for base, would form an equilateral triangle. The altitude of the triangle may be calculated by the familiar rule of the reverse of the hypotenuse. It will be found equal to nearly ninety feet. The result, though deduced by the simplest of calculations, is an astonishing one. It is enough to account for any number of "sun-kinks." The books are very prolific of instances of expansion by heat, and always speak of the expansion of rails. They do not, however, allude to the geometrical element of danger; they concern themselves only with the physical one.

It is obvious that a mile of rails would never expand in this way. Disturbances of alignment would be confined to smaller sections. The calculation shows a maximum that would never be attained. The conditions might be fulfilled by four rails. For the given elevation of temperature they would expand about eight tenths of an inch, with a lateral displacement of over two feet. For an expansion through 50° Fahr., the displacement would be eighteen inches.

Two rails would act in accordance with the supposition most readily. Their total expansion, for 100° Fahr., is four tenths of an inch, and the bulge due to such expansion would be twelve inches. For half the number of degrees it would be nine inches. This shows how very small a rise of temperature might produce a spreading sufficient to throw a train from the track. The smaller figures are as impressive as the ninety feet, when it is recollected that four inches displacement of the rails might produce a catastrophe.

The distortion might be confined to a single rail; and, from what has been said, it is clear how seriously the small fraction of an inch of expansion could affect it. It is an application of the old law of the elbow-joint press reversed, the working pressure taking the place of the resistance. The work is done at a great disadvantage, but the power is almost limitless.

A very good instance of "sun-kink" could be seen some years ago on the wooden bridge leading from the elevated railroad station at One Hundred and Fifty-fifth Street, in this city, toward Ninth Avenue. A gas-pipe of wrought-iron was laid on the floor of the structure. As if to render it more susceptible to the rays of the sun, it was painted of dark color. On cold or cloudy days it lay in its normal position. On sunny days, the writer has frequently seen it bowed outward nearly or quite a foot out of line. The surface of the foot-planks under this part of it became worn by the daily friction. Finally, an arrangement of bends was introduced that operated as an expansion-joint, and now no bowing takes place.

Even 50° Fahr. seems a large rise in temperature. But it must be remembered that the temperature of rails, or similar objects, is affected by the radiant heat of the sun as well as by the atmospheric temperature. The latter is only the initial factor. The sun's rays could easily raise their absolute temperature above 100° Fahr.

NATIONAL HEALTH AND WORK.*

By Sir JAMES PAGET, F. R. S.

IT was very difficult to select, from the vast number of subjects relating to health and to education, one of which I could fitly speak today. On general education I could not venture to speak ; and, believing that I should have to address a large and various audience, I thought it would be best to choose a subject by which I might urge one of the chief objects of this Exhibition, and one which I know that you, sir, have always had in view, namely, that the public themselves should consider, much more than they do, the utility and the means of maintaining their own health. I have, therefore, chosen the relation between the national health and work ; especially as it may be shown in a few of the many examples of the quantity of work which is lost to the nation, either through sickness or through deaths occurring before the close of what may fairly be reckoned as the working-time of life. I think it may be made clear that this loss is so great, that the consideration of it should add largely to the motives by which all people may be urged to the remedy of whatever unwholesome conditions they may live in. It is a subject which is often in the minds of the real students

* Address delivered at the International Health Exhibition, London, June 17, 1884.

of the public health, but the public itself is far too little occupied with it.

I shall speak only of national health. In consideration of his own self, a man may be deemed healthy who lives idle, comfortably, and long; who enjoys every day of his life, and satisfies every natural appetite without consequent distress. And when such a one dies of old age, with a timely, uniform, and painless decay of every part, he may be deemed to have been completely healthy. And yet it is possible that he may have enjoyed his own health in the midst of a poor, unhealthy, and unhappy nation, to which he has done no good whatever.

If we could find a nation composed of people such as this man, we might be bound to speak of them as healthy; but we should be right in calling the whole nation utterly unsound, and might safely prophesy its complete stagnation, or its quick decline and fall.

It is not health such as this—idle, selfish, unproductive—that we want to promote either in the individual or in the multitude. Comfortable idleness, such as that of some vagrants and fine gentlemen, is a despicable result of good health; it is what no thorough man would ever wish for. In view of the national health and welfare, the pattern healthy man is one who lives long and vigorously; who in every part of his life, wherever and whatever it may be, does the largest amount of the best work that he can, and, when he dies, leaves healthy offspring. And we may regard that as the healthiest nation which produces, for the longest time, and in proportion to its population, the largest number of such men as this, and which, in proportion to its natural and accumulated resources, can show the largest amount and greatest variety of good work.

Here let me insert, as an interpretation clause, that in all this and what is to follow the word "man" means also "woman," and "he" means also "she"; and that, when I speak of work, I mean not only manual or other muscular work, but work of whatever kind that can be regarded as a healthy part of the whole economy of the national life. And I shall take it for granted that a large portion of all national welfare is dependent on the work which the population can constantly be doing; or, if I may so express it, that the greater part of the national wealth is the income from the work which is the outcome of the national health.

It is a common expression that we do not know the value of a thing till we have lost it; and this may be applied to the losses of work which are due to losses of national health. There are very few cases in which these can be estimated with any appearance of accuracy; but I am helped to the best within our present reach by Mr. Sutton, the Actuary to the Registry of Friendly Societies. In his office are the returns, for many years past, of the sickness and mortality among the members of a very large number of these societies; and, among other things, there is recorded the number of days which each member, when "off work" on account of sickness, receives money from his society. Hence Mr. Sutton can estimate, and this he has been so good as to do for me, the average number of days' sickness and consequent loss of work among several hundred thousands of the workmen and others who are members of these societies. From the entire mass of these returns, he deduces that the average number of days' sickness, per member per annum, is very nearly one and a half week; and this agrees, generally, with the estimates made in other societies by Mr. Neison and others. But the averages thus obtained include the cases of members of all ages, and among them many cases of chronic sickness and inability to work during old age. In order, therefore, to get a better idea of the actual annual loss of work through sickness, he has calculated the average annual number of days' sickness of each person during what may be deemed the normal working-time of life; that is, between fifteen and sixty-five years of age. This he has done among the members of the large group of friendly societies known as the Manchester Unity of Odd-Fellows; and then, on the fair assumption that the rates of sickness of the whole population during the working years of life would not be far different, he has calculated the following tables, showing the average annual rates of sickness of each person enumerated in the census of 1881, as living between the ages of fifteen and sixty-five:

AGES.	Number of males: Census of 1881 (England and Wales).	Weeks' sickness per annum, according to the experience of the Manchester Unity.	Average sickness per individual per annum (in weeks).
15 to 20	1,268,269	844,428	·666
20 to 25	1,112,354	820,183	·737
25 to 45	3,239,432	3,224,134	·995
45 to 65	1,755,819	4,803,760	2·736
All ages from 15 to 65	7,375,874	9,692,505	1·314

AGES.	Number of females: Census of 1881.	Weeks' sickness per annum, according to the experience of the Manchester Unity.	Average sickness per individua per annum (in weeks).
15 to 20	1,278,963	851,701	·666
20 to 25	1,215,872	896,685	·737
25 to 45	3,494,782	3,476,146	·995
45 to 65	1,951,713	5,368,229	2·751
All ages from 15 to 65	7,941,330	10,592,761	1·334

Briefly, it appears from these tables that the average time of sickness among males during the working years is 1·314 weeks—that is, a small fraction more than nine days in each year—and that among females it is a small fraction more. The result is, that among males there is a loss of 9,692,505 weeks' work in every year, and among females a loss of 10,592,761 weeks. Thus we may believe that our whole population between fifteen and sixty-five years old do, in each year, 20,000,000 weeks' work less than they might do if it were not for sickness. The estimate is so large that it must, on first thoughts, seem improbable; but on fair consideration I believe it will not seem so. For the members of the Manchester Unity who are in the working-time of life, the reckoning is certainly true, and it is founded on the experience of between 300,000 and 400,000 members. In respect of health they may represent the whole population, at least, as well as any group that could be taken. They are not very strictly selected—they are not picked lives; yet they are such as are able, when they are in health, to earn good wages or good salaries, and, as their prudence in joining this association shows, they are comparatively thrifty and careful persons. They do not, at all events, include many of the habitual drunkards, the cripples or utterly invalids, or those who, through natural feebleness or early disease, or mere profligacy, can not earn enough to become members or maintain themselves in membership. Neither do they include many of the insane, or imbecile and idiotic, of whom there are, in our population, nearly 70,000, doing no work, and losing not less than 3,500,000 weeks' work in the year.

It would be tedious to tell the grounds on which the estimate may be deemed too high, for just as many and as good could be told on which it might be deemed too low. And it is rather more than confirmed by some estimates of the annual sickness in other and very different groups of persons.

In the army, at home, the average number of days' sickness in each year is, for each soldier, about seventeen; and, as the number of the troops in the United Kingdom is more than 80,000, we have here a loss of about 200,000 weeks' service in each year.

In the navy, on the home stations, the average number of days' sickness in each year has been in the last five years for each man nearly sixteen; so that for the total of about 20,000 men there is a loss of 45,000 weeks' service in each year.

The amount of sickness in the services thus appears much higher than in the friendly societies. This is due, in great part, to the fact that a soldier or a sailor is often put off duty a day or two for much less illness than that for which a civilian would "go on his club." Still, the one estimate may confirm the other; for the sickness in the army and navy is that of picked men, who were selected for the services as being of sound constitution, and who are in what should be the best working years of life: and, if it includes many cases of sickness for only a day or two, it excludes nearly all cases of more than a few months, such as make up a heavy proportion of the average sickness in the friendly societies and in the general population.

And I may add that the estimate from these societies, that nine days in the year may justly be thought a fair estimate of the working-time lost by sickness, is confirmed by the records of sickness among the 10,000 members of the metropolitan police force ; for among these, including cases of long illness such as are also in the societies, the average is more than nine days in the year.

I think, then, that we can not escape from the reasons to believe that we lose in England and Wales, every year, in consequence of sickness, 20,000,000 weeks' work ; or, say, as much work as 20,000,000 healthy people would do in a week.

The number is not easily grasped by the mind. It is equal to about one-fortieth part of the work done in each year by the whole population between fifteen and sixty-five years old. Or, try to think of it in money. Rather more than half of it is lost by those whom the Registrar-General names the domestic, the agricultural, and the industrial classes. These are more than 7,500,000 in number, and they lose about 11,000,000 weeks ; say, for easy reckoning, at £1 a week ; and here is a loss of £11,000,000 sterling from what should be the annual wealth of the country. For the other classes, who are estimated as losing the other 9,000,000 weeks' work, it would be hard and unfair to make a guess in any known coin ; for these include our great merchants, our judges and lawyers, and medical men, our statesmen and chief legislators ; they include our poets and writers of all kinds, musicians, painters, and philosophers ; and our princes, who certainly do more for the wealth and welfare of the country than can be told in money.

Before I speak of any other losses of work or of wealth due to sickness, permit me, as in parentheses, to point out to you how very imperfectly these losses are told, or even suggested by our bills of mortality. These, on which almost alone we have to rely for knowing the national health—these tell the losses of life, and more than misery enough they tell of ; but to estimate rightly the misery of sickness, and the losses of all but life that are due to it, we need a far more complete record than these can give.

Take, for example, such a disease as typhoid fever—that which Mr. Huxley has rightly called the scourge and the disgrace of our country. It has of late destroyed, in England and Wales, among persons in the working-time of life, nearly 4,000 in the year. Its mortality is about fifteen per cent, so that, if in any year 4,000 die of it, about 23,000 recover from it. Of these, the average length of illness is, on the authority of Dr. Broadbent, about ten weeks. Here, therefore, from one disease alone, and that preventable, we have an annual loss of 230,000 weeks' work, without reckoning what is lost with those who die. And the same may be said of nearly all the diseases that are most prominent in the bills of mortality. The record of deaths, sad as it is, tells but a small part of the losses of happiness and welfare that are due to sickness. It is as if in a great war we should have a regular return of the numbers killed, but none of the numbers wounded, though these, more than the killed, may determine the issue of the war.

Let me now tell of another loss of work and of money through sickness and early death. In all the estimates I have yet referred to, no account is taken of those who are ill or die before they are fifteen years old. They are not reckoned as in the working-time of life, though in some classes many thousands of them are. (In the domestic, agricultural, and industrial classes of the Registrar-General nearly half a million of them are included.) And yet the losses of work due to sickness among children must be very large. Consider the time which might be spent in good productive work, if it were not spent in taking taking care of them while they are ill. Consider, too, the number of those who, through disease in childhood, are made more susceptible of disease in later life, or are crippled, or in some way permanently damaged ; such as those who become deaf in scarlet fever, or deformed in scrofula or rickets, or feeble and constantly invalid, so that they are never fit for more than half-work, or for work which is only half well done. These losses can not be counted, but they must be large ; and there are others more nearly within reckoning ; the losses, namely, which are due to the deaths of those who die young. If they had lived to work, their earnings would have been more than sufficient to repay it ; but they have died, and their cost is gone without return. The mortality of children under fifteen in 1882 was nearly a quarter of a million ; what have they cost ? If you say only £8 a piece, there are more than £2,000,000 sterling thus lost every year. But they have cost much more than this, and much more still is lost by the loss of the work they might have lived to do.

It is, indeed, held, I believe, by some that these things should not be counted as losses ; that we have a surplus of population, and that really the deaths of children, though they may be the subjects of a sentimental sorrow, can not reasonably be regretted. I can not bring myself to admit that such a thing should even be argued. I have lived long in the work of a profession which holds that wherever there is human life it must be preserved ; made happy, if that can be ; but, in any case, if possible, preserved ; and no argument of expediency shall ever make me believe that this is wrong. Indeed, I am rather ashamed—even for the purpose I have in view—to use so low an argument as that of expediency in favor of the saving of health and of life. I am ashamed of making money appear as a motive for doing things for which sufficient motives might be found in charity and sympathy, and the happiness of using useful knowledge ; but it seems certain that these are not yet enough for all that should be done for the promotion of the national health ; therefore, it seems well to add to them any motives that are not dishonorable ; and so I add this, that we lose largely not only in happiness but in wealth by the deaths of these poor children.

I will add only one more illustration of these losses, which is always suggested by looking at tables of mortality. The deaths of persons between twenty-five and forty-five years old, that is during what may be deemed the twenty best working years of life, are annually between 60,000 and 70,000; in 1882 they were 66,000. Think, now, of the work lost by these deaths; and of how much of it might have been saved by better sanitary provisions. If one looks at the causes of their deaths, it is certain that many might have been prevented, or, at least, deferred. Say that they might have lived an average of two years more; and we should have had in this year and last an increase of work equivalent to that of at least 6,000,000 weeks; as much, in other words, as 6,000,000 people could do in one week.

More instances of losses of work by sickness and premature death might easily be given, but not easily listened to in this huge hall. Let these suffice to show something of our enormous annual loss, not only of personal and domestic happiness—that is past imagining—but of national power and wealth. Surely we ought to strive more against it.

But, some may ask, can these things be prevented? are they not inevitable consequences of the manner of life in which we choose or are compelled to live? No; certainly they are not. No one who lives among the sick can doubt that a very large proportion of the sickness and the loss of work which he sees might have been prevented; or can doubt that, in every succeeding generation, a larger proportion still may be averted, if only all men will strive that it may be so.

Let me enumerate some of the chief sources of the waste as they appear to one's self in practice.

Of the infectious fevers, small-pox might be rendered nearly harmless by complete and careful vaccination. Typhus and typhoid, scarlet fever and measles might, with proper guards against infection, be confined within very narrow limits. So, probably, might whooping-cough and diphtheria.

Of the special diseases of artisans there are very few of which the causes might not be almost wholly set aside. Of the accidents to which they are especially liable, the greater part, by far, are due to carelessness.

Of the diseases due to bad food and mere filth; to intemperance; to immorality—in so far as these are self-induced—they might, by self-control and virtue, be excluded. And with these, scrofula, rickets, scurvy, and all the wide-spread defects related to them, these might be greatly diminished.

It can only be a guess, but I am sure it is not a reckless one, if I say that of all the losses of work of which I have spoken, of all the millions of weeks sadly spent and sadly wasted, a fourth part might have been saved, and that, henceforth, if people will have it so, a still larger proportion may be saved.

We may become the more sure of what may be done by looking at what has been done already. Let me show some of it; it will be a relief to see something of the brighter side of this picture.

In a remarkable paper lately read before the Statistical Society, Dr. Longstaff says, "One of the most striking facts of the day, from the statistician's point of view, is the remarkably low death-rate that has prevailed in this country during the last eight years." In these years the annual death-rate has been less than in the previous eight years in the proportion of two deaths to every 1,000 persons living. The average number of deaths has been 50,000 less in the last than in the previous eight years. Doubtless many things have contributed to this grand result, and it is not possible to say how much is due to each of them; but it would be unreasonable to doubt that the chief good influence has been in all the improved means for the care of health which recent years have produced. This is made nearly certain by the fact that the largest gains of life have been in the diminution of the deaths from fever, and of the deaths in children under fifteen years old; for these are the very classes on which good sanitary measures would have most influence.

The annual number of deaths from typhus, typhoid, and the unnamed fevers, has been about 11,000 less than it was about twenty years ago. The annual number of deaths of children under five years old has been about 22,000 less than it was; and that of children between five and fifteen has been upward of 8,000 less.

These are large results, and, though they tell only of deaths, yet they bear on the chief subject I have brought before you—the working power of the nation; for, however much we might assign to improved methods of medical treatment of fever, yet the diminished number of deaths means a very large diminution in the total number of cases. The deaths during the working years of life were 6,500 less; and, this being so, we may hold that, if the average mortality was, say, twenty-five per cent, the diminution in the total number of cases must have been at least 25,000; and if we may believe, as before, that each of these involved ten weeks of sickness, we have, in these fevers alone, a clear saving of 185,000 weeks' work in every year.

And so with the diminution of the mortality among children, there must have been a greater diminution in the number of costly and work-wasting illnesses, and a large saving of money that would otherwise have been sunk. And not only so: but many of the children saved in the last eight years will become bread-winners or care-keepers; and who can tell what some of them will become; or what the world would have lost if it had lost all of them?

Let me add only one more reckoning. In a paper last year, at the Statistical Society, Mr. Noel Humphreys showed that "if the English death-rate should continue at the low average of the five years 1876–'80, the mean duration of male life in this country would be increased by two years, and that of female life by no less than 3·4 years as compared with the English life-table." And he showed further that "among males seventy per cent and among females sixty-five per cent of this increased life would be lived between the ages of twenty and sixty years, or during the most useful period."

I should like to be able to tell the value in working-power of such an addition to our lives. It is equal to an addition of more than four per cent to the annual value of all the industry, mental and material, of the country.

But some will say—admitting that it is desirable, seeing how keen the struggle for maintenance already is, Can more than this be done? and the answer may be and must be, Much more. In this, as in every case of the kind, every fruit of knowledge brings us within reach of something better. While men are exercising the knowledge they possess, they may be always gaining more. This Exhibition has scores of things which are better helps to national health than those of the same kind which we had twenty years ago, and with which the gains already made were won. If I were not in near official relation with the jurors, I would name some of them: there are truly splendid works among them.

But do not let me seem to disparage the past in praising the present. It is difficult to speak with gratitude enough of what has been done, even though we may see, now, ways to the yet better.

Any one, who has studied the sources of disease during the last thirty years, can tell how and where it has diminished. There is less from intemperance, less from immorality; we have better, cheaper, and more various food; far more and cheaper clothing; far more and healthier recreations. We have, on the whole, better houses, and better drains; better water and air; and better ways of using them. The care and skill with which the sick are treated in hospitals, infirmaries, and even private houses, are far greater than they were; the improvement and extension of nursing are more than can be described; the care which the rich bestow on the poor, whom they visit in their own homes, is every day saving health and life; and, even more effectual than any of these, is the work done by the medical officers of health, and all the sanitary authorities now active and influential in every part of the kingdom.

Good as all this work has been, we may be sure it may become better. The forces which have impelled it may still be relied on. We need not fear that charity will become cool, or philanthropy inactive, or that the hatred of evil will become indifference. Science will not cease to search for knowledge, or to make it useful when she can; we shall not see less than we do now, and here, of the good results of enterprise and rivalry, and of the sense of duty and the sorrow of shame that there should be evil in the land.

What more, then, it may be asked, is wanted? I answer, that which I have tried to stir: a larger and more practical recognition of the value and happiness of good national health; a wider study and practice of all the methods of promoting it; or, at least, a more ready and liberal help to those who are striving to promote it. In one sentence, we want the complete fulfillment of the design of this Exhibition, with all the means toward health and knowledge that are shown in it, and with its hand-books, lectures, conferences, and the verdicts of its juries.

We want more ambition for health. I should like to see a personal ambition for renown in health as keen as is that for bravery, or for beauty, or for success in our athletic games and field-sports. I wish there were such an ambition for the most perfect national health as there is for national renown for war, or in art or commerce. And let me end soon by briefly saying what I think such health should be.

I spoke of the pattern healthy man as one who can do his work vigorously wherever and whatever it may be. It is this union of strength with a comparative indifference to the external conditions of life, and a ready self-adjustment to their changes, which is a distinctive characteristic of the best health. He should not be deemed thoroughly healthy who is made better or worse, more or less fit for work, by every change of weather or of food; nor he who, in order that he may do his work, is bound to exact rules of living. It is good to observe rules, and to some they are absolutely necessary, but it is better to need none but those of moderation, and, observing these, to be able and willing to live and work hard in the widest variations of food, air, clothing, and all the other sustenances of life.

And this, which is a sign of the best personal health, is essential to the best national health. For in a great nation, distributed among its people, there should be powers suited to the greatest possible variety of work. No form or depth of knowledge should be beyond the attainment of some among them; no art should be beyond its reach; it should be excellent in every form of work. And, that its various powers may have free exercise and influence in the world, it must have, besides, distributed among its people, abilities to live healthily wherever work must be or can be done.

Herein is the essential bond between health and education; herein is one of the motives for the combination of the two within the purpose of this Exhibition; I do not know whether health or knowledge contributes most to the prosperity of a nation; but no nation can prosper which does not equally promote both; they should be deemed twin forces, for either of them without the other has only half the power for good that it should have.

It is said, whether as fact or fable, that the pursuit of science and of all the higher learning followed on the first exercise of the humanity which spared the lives of sick and weakly children; for that these children being allowed to live, though unfit for war and self-maintenance, became thinkers and inventors. But learning is not now dependent on invalids; minds are not the better now for having to work in feeble bodies; each nation needs, for its full international influence, both health and knowledge, and such various and variable health, that there should be few places on earth or water in which some of its people can not live, and multiply, and be prosperous.

If, therefore, we or any other people are to continue ambitious for the extension of that higher mental power of which we boast, or for the success of the bold spirit of enterprise with which we seek to replenish the earth and subdue it; if we desire that the lessons of Christianity and of true civilization should be spread over the world, we must strive for an abundance of this national health—tough, pliant, and elastic—ready and fit for any good work anywhere.—*Journal of the Society of Arts.*

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

CARE OF OTHERS AS A DUTY.—(CONTINUED.)

BUT we recognize the necessity of a more thorough altruism than that which merely considers the rights of others. That a community should progress as it ought, each member of the body social should feel that it is a part of his personal duty to consider the well-being of the rest. The weakness and the want of skill, the ill-health and the imperfect education of his fellows, are injurious to him and to all. In such degree as weakness or want of skill affects the productive power of some members of the community, the comfort and happiness of the stronger and more skillful are affected. The weak and inefficient members, who can not provide for themselves, must be provided for somehow. The trouble to the community which would arise from any plan for leaving the weak and unskillful unprovided for would be much more serious than the loss arising from the efforts made to help them. But these efforts being so much deducted from the general efforts of the stronger and more skillful members of the body social must be counted as loss. So that it is the interest of all to see that there may be as few weak and unskillful persons in the community as possible.

In like manner the sickness of our fellows is a matter in which we are interested. Apart from the necessity of restoring the sick to such health and strength as may fit them to take their part in the work of the community, the illness of others may bring illness to ourselves. Fever and pestilence, though they may first attack the weak, presently extend their attacks to those who had been strong. If even a man should feel no anxiety on his own account, those dear to him, those dependent on him, or those on whom perhaps he is in greater or less degree dependent, may succumb to such attacks. Considering all the evils, near and remote, which may follow from an epidemic, we recognize the necessity of adopting all such altruistic measures as may avail to diminish the chance of such diseases arising, or to limit their range of action when they have once found footing. No doubt egoistic considerations here seem to suggest altruistic duties; but these altruistic duties can not be properly undertaken or discharged unless they have become habitual and are referred to a real care and regard for others independently of consequences, more or less remote, to self. Apart from which, the discharge of such altruistic duties will be more satisfying and more pleasant if they are spontaneously undertaken.

Similar considerations apply to education in all its various forms. In other words, we must consider the mental as well as bodily weaknesses, and the mental as well as bodily diseases, of our fellow-citizens. Where those around us are stupid and unintelligent, where they attempt no improvements, where they have little inventive capacity and little readiness to use even such as they have, we suffer along with them. The mere stupidity of the great mass of most communities with regard to the system of government they consent to be ruled by may mean most serious injury and discomfort to all, foolish and intelligent alike. Those who see what is needed, or at least the direction in which improvement may reasonably be sought, yet remain silent in the belief that it is no business of theirs, are as unintelligent as those who stupidly assent to what—without thinking—they suppose to be good for them and to be provided for by those who know better than themselves; though often, when traced to their source, the measures in vogue are found to be of no better origin than the body itself which submits to them.

A low standard of intelligence in the community affects the welfare of all, in many different ways. Wrong ideas about the relation of the nation to other nations may seem unimportant in the case of persons who take no direct part in political matters. But in reality a very notable influence is exerted by the community generally on the conduct of those who have charge of political affairs. Wrong counsels in the cabinet may be advanced or right counsels hampered by stupidity in the country at large. Statesmen themselves are not always so wise or often so firm that they are not influenced by prevalent ideas; and so far as mere numbers are concerned prevalent ideas are likely to be foolish ideas. Fortunately, mere numbers may not suffice to give weight to prevalent stupidity. Many of the unwise are influenced by the observed fact that such and such men conduct affairs successfully, and so are led to support the wiser sort, not through sound judgment on their own part, but from that kind of sense which leads the ignorant to defer to the judgment of the better-informed. But this does not prevent the average intelligence of the community from being a matter of great moment even in political matters—supposed to be guided always by the wisest, despite the true saying that the world is governed with but a small amount of wisdom. What I have here said has no relation to the action of kings, princes, and the like, who in English-speaking communities can not now injuriously influence political relations except through the weakness or folly of statesmen. Yet the argument might be strengthened by calling attention to the way in which, even within the last thirty years, our own country has suffered in this special direction, statesmen weakly or foolishly yielding to public pressure by which the unwise counsels of princes have been supported. A hundred years ago our country saw in still more marked way how the average want of intelligence of the many, supporting the stupidity of a king (of alien race, in that case), may go near to wreck the fortunes of a great race. We may hope, however, that no such trouble is in store for us hereafter as afflicted the British people when a foolish people insanely strengthened the hands of a mad king.

In social matters a low standard of general intelligence is a serious evil, which a wise altruism will endeavor to diminish. "*I do not mean,*" I may here say with Mr. Herbert Spencer, "*such altruism as taxes rate-payers that children's minds may be filled with dates and names and gossip about kings and narratives of battles and other useless information, no amount of which will make them capable workers or good citizens ; but I mean such altruism as helps to spread a knowledge of the nature of things, and to cultivate the power of applying that knowledge.*"

It is hardly necessary to multiply examples. We are confronted at every step by the harmful effects of prevalent want of intelligence. The fire which is intended to warm your room is so stupidly placed that it sends the better part of the heat up the chimney and creates cold draughts round your legs. Equally obnoxious to the understanding is the window by which you seek to ventilate your room. It is a struggle to open it, a struggle to close it, unless when your head is in the way, when it generally descends in effective guillotine-fashion. The carpeting of your room is an absurdity, the papering (apart from any question of beauty) a monstrosity. The gaseliers are so ingeniously arranged that you get a minimum of light and a maximum of heat and foul air. The chair you sit on seems intended to make you uncomfortable ; as you draw it up to the table you find that the senseless people who plan furniture have provided sharp corners just where your knees are most likely to be caught. If you wish to lie down or to recline on a sofa, you find the head of the sofa so ingeniously padded that, while too sloped for reclining, it is not sloped enough for you to lie on it comfortably.* Your child, running in for a kiss from

* I fear Mr. Foster refers to that abomination of desolation, the Alexandra sofa, which certainly for hideousness and utter unfitness for all the uses of a sofa is a marvel of

papa, stumbles over a footstool so carefully colored like the carpet that it did not catch his eyes but his feet; and, falling, is hurt severely by a sharp projection on chair, sofa, table-leg, fender, scuttle, or what not, where no sharp projections are wanted, and none ever should be. In numberless ways miseries, individually small, but effectively diminishing happiness, result from general want of intelligence. "Unpunctuality and want of system," again, as Mr. Herbert Spencer points out, "are perpetual sources of annoyance. The unskillfulness of the cook causes frequent vexation and occasional indigestion. Lack of forethought in a house-maid leads to a fall over a bucket in a dark passage; and inattention to a message, or forgetfulness in delivering it, entails failure in an important engagement."

It is thus the interest of each one of us, and being also for the good of all becomes the duty of each, to be altruistic in regard to the mental progress of the community—"we benefit egoistically by such altruism as aids in raising the average intelligence."

But we are equally interested in the improvement of the moral feeling pervading the social body. The happiness of the whole community is diminished by the prevalence of unconscientious ways. In small matters as in large the principle prevails. We are all interested in helping to teach men the duty of considering the rights and claims of others. From the man who hustles others off the pavement or occupies an unfair share of what should be general conversation, to the man who swindles by gross aggressions or serious breach of contract, the products of a state of low average morality diminish the happiness of the community. The aggregate of discomfort wrought by paltry offenses is serious though each separate offense may produce but slight mischief. Moreover, offenses paltry in themselves may produce very serious results. The disobedience of a nurse in some small matter (such as taking her charge to this or that place) may lead to accident affecting life or limb, or to disease ending in permanent injury or in death. In other ways, mischievous results of greater or less importance are brought about by defective moral sense in small matters, while, when we consider the effects of want of conscientiousness in business, we recognize still more clearly how much we are all concerned in the moral improvement of the community. "Yesterday," says Mr. Herbert Spencer, "the illness of a child due to foul gases led to the discovery of a drain that had become choked because it was ill-made by a dishonest builder under supervision of a careless or bribed surveyor. To-day workmen employed to rectify it occasion cost and inconvenience by dawdling, and their low standard of work, deter-

idiotic absurdity. Nine tenths of our sofa and arm-chair patterns, however, are "too absurd for any use," as they say in America. Among my own pet abominations I may mention nearly all the methods (save the mark!) for curtaining windows, the ridiculous ways in which looking-glasses are swung, the preposterously unscientific forms of ink-stands, and some others *quæ nunc perscribere longum*.—R. P.

mined by the unionist principle that the better workers must not discredit the worse by exceeding them in efficiency, he may trace to the immoral belief" (well put !) "that the unworthy should fare as well as the worthy. To-morrow it turns out that business for the plumber has been provided by damage which the brick-layers have done." And so daily and hourly do we feel that the moral imperfections of the community are fit subjects for such altruistic efforts as may help to raise the average morality.

While we thus recognize that our well-being depends so greatly on the well-being of others—their health and bodily capacities, their sense and knowledge, and their moral qualities—that due regard for others is essential to the happiness of self, we see further that each member of the body social gains directly by the possession and exercise of such qualities as lead or enable him to help his fellows. Among the proverbs which present in brief the ideas of a race as to what is good and bad, are many which imply that regard for the interest and welfare of others is bad policy. Such proverbs can not be regarded as expressing "the wisdom of many" by "the wit of one," for experience proves abundantly that the policy of hardness and indifference is unwise and short-sighted. Even mere material success—which does not always mean happiness—is not advanced in the long-run by disregard of others. The man of business gains in unnumbered ways by consideration for the rights and interests of his fellow-workers, and loses in as many by selfish disregard for them. Nay, even in the trivial affairs of ordinary life, at home and abroad, the kindly and considerate gain constantly, while the careless and indifferent as constantly suffer. It is, however, when we consider happiness as distinguished from mere material success, and the general balance of comfort and enjoyment as distinguished from the effects of individual actions, that we see how much men gain by sympathetic and kindly conduct. We see even first-rate abilities and untiring energy beaten easily in the race of life by the kindliness which makes friends of all around and leads to opportunities which the hard and ungenial fail to obtain. But when we rightly apprehend the nature of life, and what makes life worth living, we find the chief gain of the kindly, not in these material opportunities, but in the pleasanter ways along which their life's work leads them. Compare two men, toward the evening of life, of whom both perhaps have achieved a fair amount of material success in life, but one of hard, unkindly manners, the other genial and sympathetic; one alone in life's struggle, the other with "troops of friends" from first to last. Who can doubt, as he compares the worn and weary look of one with the bright and cheerful aspect of the other, that regard for others counts for something toward the welfare and the happiness of self?

Care for others helps so surely in life's struggle that it would be good policy for the naturally hard man to benefit others for purely selfish motives, and still better policy to cultivate kindliness and consideration as qualities sure to be fruitful of profit. The kindly nature which leads to spontaneous good-will toward others, independently of any consideration of gain to self, is even more profitable than cultivated kindliness. Those are lucky who possess such a nature—lucky rather than deserving of special credit, seeing that a sympathetic nature is born in a man, not made by culture. Yet the will has much to do with the development of kindliness; and many, by sensible reflection and constant watchfulness over the undue promptings of self, have trained themselves to a kindliness and geniality of manner such as they were not naturally gifted with, and this without any direct reference to self-interest, but as a matter of right and justice to their fellows. Such men deserve much credit for their care in correcting inherent tendencies to undue care of self. The increased happiness of their lives (in so far at least as happiness depends on conduct) is their reward.

Among the good effects of kindly regard for others we may note the reflected happiness derived from those around. Men vary with their company, and undoubtedly the man of sympathetic temperament whose presence is a pleasure to others finds others much pleasanter in their relations with him than they would be were he of hard, ungenial nature. The wife and children of the kindly man are a constant pleasure to him, where the wife and children of the sour-tempered, ungenial husband and father are apt to grow gloomy and quarrelsome. His friends and relatives are kindlier than those of the harsh and selfish. Abroad, he sees few faces which do not reflect something of his own brightness and cheerfulness. As Mr. Herbert Spencer well says: "Such a one is practically surrounded by a world of better people than one who is less attractive: if we contrast the state of a man possessing all the material means to happiness, but isolated by his absolute egoism, with the state of an altruistic man relatively poor in means but rich in friends, we may see that various gratifications not to be purchased by money come in abundance to the last, and are inaccessible to the first."

But in yet other ways do we find illustrated by the effects of due care for others the saying, "To him that hath shall be given, and from him that hath not shall be taken even that which he seemeth to have."

Not only has the hard and ungenial man fewer gratifications, but those which he has he enjoys less than the man who cares for the wants and wishes of others. The one loses the power of enjoyment through his over-anxiety for self-gratification, the other unconsciously pursues—through his kindliness of character—the very course which a wise and thoughtful consideration of the plan best qualified to secure self-gratification would suggest. The one, while caring unduly for himself, is exhausting and satiating his power to care for any form of pleasure, the other while ministering to the enjoyments of others is fostering his own capacity for enjoyment. Here again, if one wished to suggest a course of action by which a man who suffered from life-weariness might again know the charm of happiness, one could advise no better course than to minister systematically to the enjoyments of those around. The very tide of life is made fuller thus, even as the tide of thought is made fuller by turning from mere reflection to a interchange of ideas and thoughts with those around. While there is work to be done in the way of increasing others' happiness, no man—not even the most jaded and satiated—need ask himself the sickly question, "Is life worth living?"

Especially is this so when the tide of life is ebbing. Mr. Spencer's words on this point are worthy of careful study, by those in particular who know of him only as the teacher of some hard, unsympathetic system of Gradgrindian philosophy, for they afford an apt example of his kindly and lovable teaching:

"It is in maturity and old age that we especially see how, as egoistic pleasures grow faint, altruistic actions come in to revive them in new forms. The contrast between the child's delight in the novelties daily revealed and the indifference which comes as the world around grows familiar, until in adult life there remain comparatively few things that are greatly enjoyed, draws from all the reflection that as years go by pleasures pall. And, to those who think, it becomes clear that only through sympathy can pleasures be indirectly gained from things that have ceased to yield pleasures directly. In the gratifications derived by parents from the gratifications of their offspring, this is conspicuously shown. Trite as is the remark that men live afresh in their children, it is needful here to set it down as reminding us of the way in which, as the egoistic satisfactions in life fade, altruism renews them while it transfigures them."

But not only does altruism increase the pleasures of life; the exercise of the altruistic qualities is in itself pleasurable. The state of mind when kindly actions are performed affords pleasure. It directly increases happiness, and thus (like other pleasures) enhances physical well-being. It is true that a sympathetic nature suffers where a hard and callous nature would feel no pain. Undue altruism has no doubt its bad effects, nor can it be denied that even such altruistic feelings as are desirable for the social well-being cause, at times, some degrees of suffering; but the exercise of the altruistic qualities is in the main pleasurable, and it can not be doubted that altruistic emotions give more pleasure than sorrow. When we sorrow for a friend's grief we experience pain and undergo such depression of the vital functions as always accompanies pain; but in the long-run the joy felt in sympathy with the joys of others surpasses the sorrow occasioned by their troubles.

Then, too, it must be remembered that those pleasures which we derive from the arts owe a large part of their value to altruistic emotions. Consider the pleasure given by a painting representing a scene which moves our sympathies, or the delight with which we read some work of fiction in which kindly emotions are dealt with, and it will be seen how large a portion of our æsthetic gratifications depend on our sympathy with others. The hard and selfish care little for art and nothing for fiction. How should we bear to lose the pleasures which painting and sculpture, music and fiction, afford us? How even should we bear to change the pleasures given by the kindly and sympathetic art of to-day for the harsher effects of the arts of harder times when only deeds of conquest or ceremonial observances were represented in paintings and sculptures, suggested in musical strains, or recited in story or in song? What material gains, what sensual gratifications, what power, wealth, or fame, would make up (to us) for the pleasure we derive from the higher emotions? and how largely do these depend on the sympathies by which men are moved to loving care for the well-being of their fellows!

It remains lastly to be noticed that as there should be thought for others, and for the just rights and interests of others in the family, in the society with which we are directly associated, and within the race or nation, so there should be a wider altruism having regard to the rights of other races and nations. Hitherto men have scarcely at all recognized this duty. Very gradually the sense of altruistic duty passed beyond the family to the community of families, and thence still widening to the nation formed of such communities. Men learned that as personal selfishness is in the long-run opposed to the true interests of self, so family selfishness is only a degree less pernicious. The selfishness of parochialism was in turn seen to be mischievous, though it is still prevalent enough. But the selfishness of what is called patriotism—though it is as unlike true patriotism as personal selfishness is unlike due and wise self-regard—still remains as a virtue in the minds of most men, though characterized by inherent defects akin to those which belong to personal, family, and parochial selfishness. Men fail, indeed, to recognize any selfishness in undue care for what is called a man's own country—though with but vague and indefinite meaning. Nay, a blind love of country is regarded as something so directly the converse of selfishness, that Sir Walter Scott speaks of the absence of this sort of patriotism as simple selfishness. After asking if the man lives with soul so dead as never to have said to himself, "This is my own, my native land?" he goes on to say that such a man, a "wretch concentered all in self," can be swelled by no minstrel music, and is bound to go unmourned and unsung to an unhonored grave. The idea that patriotism could under any circumstances be exaggerated, and become but a widened form of selfishness, would doubtless have outraged utterly Scott's sense of the fitness of things. Yet viewing matters from the outside, and, as far as possible, independently of inbred ideas, there is nothing except its wider range to distinguish the selfishness of exaggerated patriotism from personal or family selfishness.

That patriotic selfishness is mischievous in its effects would scarcely need showing if men were not so ready as they are to be deaf to the teachings of experience. The well-being of other nations is in the same sense essential to the well-being of our own nation as the well-being of other members of the body social is essential to our own personal well-being. The misfortunes of any nation with which our own has relations are misfortunes to our own nation, however they may be brought about, whether by internal misgovernment, by the attacks of other nations, or by our own warlike measures. There can be no doubt, for example, that the loss incurred by Germany, the victor, was only less than the loss incurred by France, the conquered, in the disastrous Franco-German War. Other nations suffered greatly, but Germany more, and France most of all. In the war with Russia, in 1854–'55, all Europe suffered. In the American civil war not only all the United States but the whole world incurred loss. It is easy for nations to blind themselves, nay, most nations are naturally blind, to the losses suffered by each through the misfortunes of others. But there can be no doubt about the actual facts. The British race would have been taught the lesson long since, if the lesson could reach the average national mind through experience—for we are suffering, have long been suffering, and long must suffer, from the energetic efforts of our "imperial" race to get the better of other races. Directly and indirectly, in loss of blood and material, in the paralysis of trade as well as in increased expenditure, our people has to pay for its imperial instincts, just as the man of overbearing, hard, and selfish nature has to pay in many ways for the gratification of his instincts imperious. There are the same reasons, based on material profit, for inculcating just and considerate dealings between peoples as there are for encouraging just and considerate dealings between man and man. But at present nations delight in proclaiming themselves selfish and overbearing ; the more brutal instincts which remain dominant in nations after they have begun to die out in individuals are upheld as virtues, much as in old times many races regarded the more brutal qualities of humanity as chief among the virtues.—*Knowledge.*

THE PROBLEM OF POPULATION.

By CHARLES MORRIS.

IN passing through the open galleries of that busy ant-hill called a city, with its endless ebb and flow of human beings, intent on their various pursuits of business or pleasure, and succeeding each other in a seemingly endless procession of busy life, there is apt to rise forcibly before our minds the vital questions of human fecundity, and of the ability of the earth to sustain its increasing multitude of human inhabitants. But in reading the statistics of this subject our interest in it redoubles. When we find men in all nations and in all ages pressing sharply on the means of subsistence, the loss by famine quickly replaced by new food for famine, the ravages of war and pestilence rapidly obliterated by new-growing populations, and apparently nothing but the pressure of sheer want and misery able to limit human fecundity, we may well question if this is to be the continued destiny of mankind, and if there is no possible limit to population within this sharp boundary of distress.

Nearly a century has elapsed since Malthus published his disheartening researches on this subject, and his conclusions yet remain only in part refuted. If it really be, as he declares, that population tends to increase in a geometrical ratio, while the food-supply increases only in an arithmetical ratio, his conclusion, that population has a constant tendency to run ahead of subsistence, seems inevitable. Fortunately, however, his hypothesis, so far, has been proved only by arguments, not by irrefutable facts. The numbers of mankind, it is true, have frequently passed the boundary which divides want from plenty. But the other requirement of the Malthusian doctrine was not, in those cases, attained. Food-production has never yet reached its limit, and the suffering so far caused by want of food might have been entirely obviated had the earth been fully cultivated. It may, however, be claimed by disciples of Malthus that this fact has nothing to do with the question, and that, when the utmost food-production has been attained, population will still press beyond it to the starvation limit. This argument we venture to dispute. The attainment of a great food-production introduces certain conditions into the problem which may give it an entirely different aspect. Such excessive production will require, for instance, a marked advance in human intelligence, and the replacement of much of the muscular labor of mankind by an active mental labor. It is our purpose to consider what effect this changed condition of the human race will have upon the increase of population. It is easy to point to modern instances in which the rapid increase of population has been checked without special exercise of the starvation influence. The population of France, for instance, has been almost stationary for many years, its increase being much below the corresponding increase of wealth in that country. Thus France furnishes a practical argument against the Malthusian hypothesis, and shows that the growth of population may decline from other causes than vice, misery, and disease.

There exist, in fact, three separate checks to the increase of population. These may be here classed as the physical, the mental, and the physiological. The first and second of these have been fully considered by writers on political economy. The third has been barely glanced at. And yet this third may contain the true solution of the difficult problem, and through its active operation the geometrical increase of Malthus may, perhaps, be succeeded by a stationary condition of human population.

By the physical check we mean the effect of all the forces which act from outside upon the individual—such agencies as war, famine, pestilence, exposure, climatic changes, and all similar destructive influences. The mental check refers to influences proceeding from the mind of the individual. It is what is usually called the prudential check, through which individuals wisely decline to bring into the world children who must be exposed to inevitable misery, or governments restrain injudicious marriages by enactments looking to the same end. The physiological check is also internal in its origin, but not voluntary. It consists of that limit to human fecundity which is caused by employment of the organic forces in other directions.

Of these three checks to population the second only is fully under the control of the individual himself. The physical check largely arises from the action of other individuals, such as the war-making powers. It also largely flows from the hostile energies of Nature, and may, in this direction, be partly set aside by individual effort, through attention to the laws of health, and prudent avoidance of injurious conditions. The physiological check is beyond the reach of the will. It is a natural effect of human development, needs no forced restraint from marriage for its operation, and is consistent with the most natural and desirable of human relations.

Of the three checks to population here named, we will, in this paper, consider only the physiological. The others have been written upon so abundantly that there is little new to be said concerning them. It will suffice here to remark that the physical check—that which acts through the agency of famine, violence, disease, and similar influences—has ruled almost supreme in the past ages of the world, and is still vigorously active upon the great mass of mankind. The prudential check, which acts through forced desistance from marriage and child-bearing, is now actively effective in several of the more advanced European nations, probably most fully in France, and has gone far toward negativing the action of the Malthusian law. The physiological check, which we have here to consider, has also been somewhat effective in the past, but its highest influences are only now coming into play, and it promises to become an efficient and desirable agent in hindering the undue increase of human population in the future.

The principle to which we here allude has been very greatly neglected by writers on the subject of population. Those who have dealt with it have done so only cursorily, and have failed to consider it in all its bearings. It is therefore a problem that is open to further investigation. And in entering upon this inquiry it is necessary to begin with some thoughts upon organic physiology in its general relations, as preliminary to the special results desired.

The animal frame is a material organism which is kept in activity by certain energies. These energies are constantly exhausted and constantly renewed, but their vigor at any fixed period is limited, and can not be indefinitely increased. The force received from without is variously employed within the organism. It acts successively as muscular, nervous, temperature, and reproductive energy. But being limited in quantity, if it be employed by any of these organic agencies, its use by the others is restricted or prevented. Much of the energy received is used up in alimentary processes—the pursuit, seizure, mastication, and digestion of food. Only the excess over this is available for the other organic necessities. And, if this excess force be exhaustively employed by any one of the bodily agencies, it becomes unavailable for the others.

The fact here briefly stated is one which might be illustrated by numerous instances drawn from the lower animal world. A very interesting example of its influence may be perceived in the organic conditions of the ants, and, to a lesser extent, in other insect tribes. Ants, though possessed of all the organic force agencies, do not employ them all in any one individual. The males and the fully developed females exhaust all their life-force in reproduction, with little display of muscular and none of mental vigor. The remaining members of the tribe, divided into workers and soldiers, devote all their life-force to muscular and mental labor. They are, functionally, females, but their organic energies are entirely withdrawn from the reproductive agencies, and devoted to other life-purposes. Of these two classes the workers appear to have the highest mental development. The soldiers understand the whole business of fighting, but beyond that they seem incapable, and take no part in the nest-building, the food-gathering, or any other of the ant-industries. Indeed, they are too dull or too proud to even feed themselves. They would starve unless fed by the workers or slaves. And in the occasional ant-migrations the soldiers are carried bodily by the workers, neither resisting nor aiding in the labor necessary to move their high dignities. In the workers the exercise of muscular force seems to be accompanied by a considerable employment of mental energy, since they perform many actions which appear to indicate an advanced intelligence.

This illustration from the ants might be extended to the bees, and to some other insects. We might also describe the very curious and diversified separation of function in the members of the *Siphonophoræ*, or compound polyps. But there is no occasion to multiply illustrations. If we ascend to the higher animals we find no such division of function. And yet circumstances largely govern the extent to which the organic force is applied in any one direction. But we must make here a distinction which facts yet to be described render very evident. The exertion of muscular force, unless exhaustively employed, seems not injurious to the reproductive functions. Mental exertion, on the contrary, seems to restrict reproductive energy, even when not employed exhaustively.

But the animals below man do not employ mentality to any great extent. Their principal exertion is muscular, and this hinders reproduction only in case of the whole vigor of the animal being exhausted. If, for instance, the food-supplies of any animal tribe be diminished, or its numbers increased, a greater exercise of agility is required to satisfy its appetite. And if it depend on cunning or shrewdness to obtain food, its mental faculties must become very actively exercised. If these efforts become exhaustive, reproduction is necessarily restricted; while the young born under such circumstances are apt to be constitutionally weak, and unable to bear the strain of an excessive effort in food-getting. There is thus in this effect a strong check on population from strictly physiological causes.

The conclusion here reached applies equally to the lower orders of mankind. A diminution of food-supply must have an effect upon savages similar to its influence upon the lower animals. Excessive muscular exertion, extensive migratory movements, warlike efforts, and exercise of mental vigor in food-getting, which become more physically exhaustive the greater the difficulty in obtaining food, must act to greatly restrict reproductive energy, and to enfeeble the children who may be born during such an exhausted condition of their parents. The lack of sufficient nutriment is a correlative agency under the same conditions.

The physiological check, therefore, in this phase of its action, tends to prevent the Malthusian law from being other than an abstract possibility. Decrease in food-supply causes a decrease in food-consumers, through the exhaustion of organic energy in other directions than that of reproduction. And the new generation of consumers is constitutionally enfeebled, and unsuited to bear the sharp struggle of life, so that the population becomes diminished during the continuance of such conditions.

But the physiological check, in this form of its application, brings mankind too near the starvation limit to be at all desirable. There is, however, another mode in which it exercises itself, yielding far more promising results. For there is reason to believe that active mental labor is far more exhaustive of reproductive energy than is equally vigorous muscular exertion. Just what is the organic cause of this we shall not attempt to guess. It is possible that the brain, in its action, may exhaust some material necessary to germ-formation—perhaps phosphorus, which seems to be an element both of the sperm-cells and of the brain. But it is the visible results, rather than the organic causes, with which we are just now concerned.

It is an undoubted fact that the families of the poor are, as a rule, larger than those of the rich. And it is equally certain that brain-workers have, ordinarily, smaller families than muscle-workers. The industrial classes of our day do not perform exhaustive labor. Nor are they usually in the habit of strong mental exercise. The physical labor they perform seems to have no limiting effect upon their procreative powers. The families of day-laborers are usually above the average in number. And it has been observed that the pioneer inhabitants of a new country are very prolific. While physical assault upon Nature is the rule, with food abundant and easily obtained, the physiological check upon increase does not seem to strongly operate. When this first severe duty is over, and men settle down to a mental assault upon Nature, their fecundity considerably decreases. The extensive families of the pioneer settlers of this country are being replaced by the small families of the active brain-workers among their posterity.

As to whether animals that depend mainly on shrewdness are less prolific than those that trust chiefly to strength and agility, we have not sufficient facts at hand to decide. Among the lower human races there is a marked chastity and infertility in the hunter and pastoral as compared with the agricultural tribes. But the former pass lives of much greater mental excitement than the latter. The steady, regular labor of the agriculturist is replaced in the nomad by rapid variations from excessive exertion to extreme inactivity, while a constant exercise of cunning and shrewdness is necessary in the rapidly fluctuating perils and difficulties of the nomadic life.

As to the relations existing between the various classes in civilized nations, it may be mentioned that the population of country districts appears, as a rule, to be more prolific than that of cities. Until within a recent period there was hardly one of the large cities of Europe that kept up its population by the natural increase of its inhabitants. Their increasing numbers were due to continual supplies from the rural districts. The much greater mental activity of civic populations as compared with those of the country is, at least, significant in this connection. If, again, we consider the higher classes in civilized nations, it at once appears that there is a constant tendency to decrease of population in these classes, and a necessity of frequent replacement from the lower grades of society. Thus there has been, in every century, a rapid thinning out of the families in the British peerage. An incessant creation of new peers has taken place, and yet they have hardly kept up their numbers, while very few of the original noble families have an existing representative. The same thing appears in the history of ancient Rome. The early noble families were almost extinct in the time of Claudian. Those created in the reigns of Cæsar and Augustus were nearly exhausted at the period of Tacitus. Malthus says that, in the town of Berne, of 487 wealthy families, 379 became extinct in two centuries. In 1623 the sovereign council was composed of members of 112 different families, of which only 58 were in existence in a century and a half afterward.

If we consider special cases of noted men, the great generals of the world, the commanding statesmen, the distinguished scientists, the celebrated authors—all, in fact, who have become distinguished for superior mental ability—an almost universal result appears: they have either left no descendants, or their families were very small. And, for that matter, we need but to look at evidences everywhere surrounding us. We think it will be found to be a general rule that persons constantly exercised in mental labor have few or no children; those of less active minds have larger families; while the largest families belong to those who do not trouble themselves to think at all.

There is abundant reason to believe, then, that such a physiological check to population really exists; and, in its operation, it is not difficult to perceive a rich promise for the future of the human race. For it is in no sense, in its superior phase, a starvation check. Nor does it need any of the violent repression of natural desires exercised in the prudential check. At first sight, it appears as if its tendency must be to constantly place the cultured at a disadvantage in numbers as compared with the dull and ignorant. But this disadvantage is more than counterbalanced by the progress of education and the brain-incitements of modern civilization. Thus, the class of brain-workers is being continually recruited, despite its lack of fecundity, and we can see indications of an immense future augmentation of this class of the population at the expense of the unthinking, and consequently of a new barrier to the progress of population, whose efficacy is now but beginning to appear.

It is a process which must in time do away with the "starvation check" to population, and replace it with a new and far more desirable limiting principle. For when nerve-energy largely replaces muscular energy, and advanced education greatly increases the percentage of the cultured, there may be a corresponding decrease in the birth-rate, through the operation of the causes just considered. And, as human want decreases and comfort advances, the developed needs of mankind must extend the prudential check on early marriage, which is so active now in the middle classes. In this another limiting force will be brought to bear upon the increase of population.

Thus, as the sum of human wealth increases, through the exercise of intelligence in industrial operations, it will necessarily be divided among a population not increasing in an equal ratio. The average wealth of all classes of the community must increase in consequence, the necessary amount of active muscular labor be reduced, and more time be given for rest, enjoyment, or indulgence in mental culture.

The more rapidly that wealth accumulates in proportion to population, and, the more vigorously that culture forces its way downward through the community, the greater must be the effect of the prudential and physiological checks to increase of population; the final result, perhaps, being one in which the birth-rate and death-rate shall become closely allied, and a virtually stationary condition of population ensue.

We have here indications of a rich promise for the future of the human race. If the numbers of mankind become thus checked, while wealth continues to grow, and culture, with its advanced needs, becomes a general possession, the standard of desire must rise, until absolute want may no longer mean, as now, physical misery and starvation, but may mean the deprivation of what would now be considered luxuries beyond the reach of the poor. In such a case the population of the earth could never sink, as now, to press upon the sharp edge of absolute destitution. It would be too far above this limit to sway so far downward, and misery from want of food might become an obsolete tradition of the past.

PROTECTION AGAINST LIGHTNING.

I.

THE first lightning-conductor was erected by Benjamin Franklin upon his own house in Philadelphia in 1752. The invention is, therefore, now a little more than one hundred and thirty years old. Franklin was led to the investigations which resulted in its construction by the fortuitous circumstance that, about six years previously, he had been present at a lecture on electricity delivered in Boston by Dr. Spence.* In the same year—that is, in 1746—he received a present from Peter Collinson, a member of the Royal Society in London, who was also the agent of the Library Company in Philadelphia, of one of the London electric tubes, and an account of some experiments that had recently been made by Dr. Watson, Martin Folkes, Lord Charles Cavendish, Dr. Bevis, and others of their contemporaries. The idea had already suggested itself to these investigators that the luminous gleam which was elicited from glass tubes when they were rubbed in dark cellars, in performance of the frequently repeated and fashionable experiment of the day, might possibly be of a kindred nature to the lightning of the thunder-storm. In a book describing some "physico-mechanical experiments" that he had made, published in London in 1709, Francis Hawksbee remarked that the luminous flash and crackling sounds produced by rubbing amber were similar to lightning and thunder. In 1720 Stephen Gray, the pensioner of the Charterhouse, so celebrated for his electrical investigations, boldly and uncompromisingly affirmed that, "if great things might be com-

* It is, perhaps, worthy of remark that, in this lecture, the experiments were made by the primitive instrumentality of a glass rod and silk pocket-handkerchief.

pared with small," the light and sound called forth when glass rods were rubbed were of the same nature as lightning and thunder. Franklin, from the time when the electrical experiments came under his notice, enthusiastically adopted this view. In a letter written to a friend in 1749, he very clearly expressed his reasons for this belief. In this communication he insisted upon the facts that the electric spark gives light like lightning; that the luminous discharge follows a similar crooked track; that this discharge is swift in its motion, is conducted by metals, is accompanied by an explosion when it escapes, rends bodies that it passes through, destroys animal life, melts metals, sets fire to inflammable substances, and causes a smell of sulphur—all of which attributes seemed to him to point to the identity of the phenomena. He also observed that the electric discharge was attracted by points, and stated that he was bent upon ascertaining whether lightning had not the same tendency. In the autumn of the following year he wrote to Mr. Collinson to say that he had satisfied himself in this particular; that he was entirely convinced of the identity of the so-called electricity with lightning; that he believed the damage done by lightning descending from the clouds to the earth might be altogether prevented by placing iron rods, with sharp points, upon the summits of buildings; that he intended to test experimentally the soundness of his belief in that matter; and that he hoped other persons would assist him in his labors by following his example. This was virtually the definite forecast of the conductor which Franklin attached to his house in 1752.

In the mean time the suggestion that buildings might be protected from lightning by the use of iron rods with sharp points was incidentally communicated by Mr. Collinson to the editor of the "Gentleman's Magazine" in London, who, at once perceiving the practical importance of the hint, offered to print an account of Franklin's views in the form of a pamphlet. This offer was accepted, and, in the month of May, 1751, a pamphlet was published in London, entitled "New Experiments and Observations on Electricity made at Philadelphia, in America, by Benjamin Franklin." The pamphlet was not very warmly received in England, but it was enthusiastically welcomed and appreciated in France. Count de Buffon had it translated into French, and the translation appeared in Paris within four months of the publication of the original pamphlet in England. It was soon afterward translated into German, Italian, and Latin. The attention of scientific men in Paris was quickly drawn to the method of defense proposed by Franklin, and M. Dalibard, a man of some wealth, undertook to erect the apparatus at his country residence at Marly-la-Ville, some eighteen miles from Paris. The situation of the house was considered to be eminently favorable for the purpose, as the building stood some four hundred feet above the sea. A lofty wooden scaffold, supporting an iron rod an inch in diameter and eighty feet long, was erected in the garden. The rod was finished at the top by a sharp point of bronzed steel, and it terminated at the bottom, five feet above the ground, in a smaller horizontal rod, which ran to a table in a kind of sentry-box, furnished with electrical apparatus. On May 10th, when M. Dalibard was himself absent in Paris, the apparatus having been left temporarily in the charge of an old dragoon named Coiffier, a violent storm drifted over the place, and the old dragoon, who was duly instructed for the emergency, went into the sentry-box and presented a metal key, partly covered with silk, to the termination of the rod, and saw a stream of fire burst forth between the rod and the key. The old man sent for the Prior of Marly, who dwelt close by, to witness and confirm his observation, and then started on horseback to Paris, to carry to his master the news of what had occurred. Three days afterward, that is, on May 13, 1752, M. Dalibard communicated his own account of the incident to a meeting of the Académie des Sciences, and announced that Franklin's views of the identity of the fire of the storm-cloud with that of the electrical spark had been thus definitely established.

Before the success of M. Dalibard's experiment could be reported in America, however, Franklin had secured his own proof of the identity by the memorable experiment with the kite, so well known to the scientific world. He was anxiously waiting for the erection of the first steeple in Philadelphia for the opportunity which this would afford him for the support of a lofty iron rod, when the happy idea occurred to him to try, in the mean time, upon some suitable occasion, whether he could not contrive to hold up a lightning-conductor toward a storm-cloud by means of a kite. On the evening of July 4th, that is, fifty-two days after the experiment of M. Dalibard, his kite was raised during a thunder-storm, and, with the help of his son, he drew electric sparks from the rain-saturated string, as the two stood in the shelter of an old cow-shed in the outskirts of Philadelphia. He held the kite by a silken cord that was attached to a key at the bottom of the string, and with this arrangement he charged and discharged an ordinary Leyden-jar several times in succession. Franklin at first not unnaturally conceived that he had actually drawn the lightning down from the storm-cloud. He was, however, no doubt mistaken in this. The storm-cloud had inductively excited the neighboring surface of the earth, and what Franklin saw was the electric stream escaping out through the wet string toward the storm-cloud to relieve the tension set up by this induction. It was in the summer of the same year, after the performance of this world-renowned experiment with the kite, that Franklin attached to his house a lightning-conductor, which was composed of an iron rod, having a sharp steel point projecting seven or eight feet above the roof, and with its lower end plunged about five feet into the ground.

As a matter of course, the new doctrine of Franklin and his allies was not received without considerable opposition. A sharp shock of an earthquake having been experienced in Massachusetts in 1755, this was forthwith attributed to the evil influences of Franklin's lightning-rods. A Boston clergyman preached against them in 1770 as "impious contrivances to prevent the execution of the wrath of Heaven." Even as late as 1826, an engineer in the employment of the British Government recommended that all lightning-rods should be removed from public buildings as dangerous expedients, and in 1838 the Governor-General and Council of the East India Company ordered that all lightning-rods should be removed from public buildings, arsenals, and powder-magazines throughout India, and only became reconciled to their restoration after a large magazine and corning-house, not furnished with a conductor, had been blown up during a storm.

Franklin was so much in earnest in reference to his invention that he sent a friend at his own charge through the principal towns of the New England Colonies to make known the powers and virtues of the lightning-rod. In the "Poor Richard" for 1758, a kind of almanac or manual which he was at that time publishing, he gave specific instructions for the erection of his rods. The second conductor which he himself constructed was placed upon the house of Mr. West, a wealthy merchant of Philadelphia. A few months after this had been erected a storm burst over the town, and a flash of lightning was seen to strike the point of the conductor, and to spread itself out as a sheet of flame at its base. It was afterward found that about two inches and a half of the brass point had been dissipated into the air, and that immediately beneath the metal was melted into the form of an irregular blunt cap. The house, nevertheless, was quite uninjured. The sheet of flame seen at the base of the conductor Franklin correctly ascribed to the ground having been very dry, and to there not having been a sufficiently capacious earth contact under those circumstances. He nevertheless shrewdly, and quite justifiably, assumed that in this case Nature had itself pronounced an unmistakable verdict in favor of his invention.

The controversy concerning the efficacy of lightning-rods continued to agitate the councils of scientific men, notwithstanding this memorable demonstration of their efficiency; but, upon the whole, the new doctrines made their way into the confidence of the intelligent classes of the community. The most important circumstance in connection with the early fortunes of the invention, perhaps, was the admirable series of reports and instructions which were issued by the French Government between the years 1823 and 1867, and to which Mr. Anderson now once again, and not superfluously, draws public attention in his recent pamphlet entitled "Information about Lightning-Conductors issued by the Academy of Sciences of France." The first of these reports was drawn up in 1823 by Gay-Lussac, the discoverer of the law of the expansibility of gases, the companion of Humboldt, and the distinguished meteorologist who first ascended four miles and a half into the air in a balloon. The second and the third were prepared in 1854, and in 1867, by M. Pouillet, the director of the Conservatoire des Arts et Métiers in Paris, and the author of a well-known work on the elements of experimental physics and meteorology, which has been translated into many languages. These reports, although drawn up by an individual, were the results of the deliberations and experiments of a considerable number of scientific men, acting as a commission, and comprising among them such distinguished names as those of Poisson, Fresnel, Becquerel, Duhamel, Fizeau, and Regnault. In the first of these reports, that, namely, of Gay-Lussac, which was adopted by the Academy of Sciences on April 23, 1823, it was premised as a kind of axiom that there are no bodies which do not offer some resistance to the transmission of electricity, and that conductors of small diameter offer more resistance than those which are of the same composition and of larger size. The electrical state was conceived in these investigations as consisting of some kind of matter—as depending upon molecules which are mutually repulsive, and which therefore tend to separate and disperse themselves through space, and which are only retained upon the surface of solid bodies by the pressure of the atmosphere. When the electric matter escapes, it seeks the earth under its tendency to diffuse itself over the most capacious conductors it can find, selecting the most perfect of them that are within its reach, but dividing itself in proportion to their individual capacities of accommodation, when several conductors of unequal power are open to its transmission. A storm-cloud, hovering above in the air, attracts toward the nearer part of the terrestrial surface an electrical matter of a contrary nature to its own, and drives back into the ground an electrical matter of the same nature as its own. Each prominent part of the ground is therefore, for the time, in a state of electrical tension during the presence of a neighboring storm-cloud, and becomes a center of attraction toward which the lightning inclines. When the prominent object is in good connection with the ground, its electrical matter may shoot forth toward that of the cloud, and make a path between it and the cloud. If the prominent body projects as a sharp point toward the cloud, the escape of the electric matter from it to the cloud becomes very rapid, and the lightning strikes to it from the cloud, from a greater distance. It was further conceived that a good conductor protected from any violent discharge a circular space whose radius was twice the height of the rod. An iron bar three quarters of an inch square was taken to be of sufficient dimensions for the construction of a conductor, because no instance had been known of a rod a little in excess of half an inch in diameter having ever been fused or raised to a red heat by lightning. Even small rods or wires that were dispersed by the passage of lightning had served to convey it to the ground, and had protected surrounding objects from single strokes. Trees were recognized as dangerous to animals taking shelter near their trunks, because they do not convey a lightning-discharge with sufficient rapidity to the ground, and because they are worse conductors themselves than animal bodies. But the discharge will not in any case leave a good conductor, well connected with the ground, to strike a living animal placed near its course. The terminal rod of a conductor was ordered to be two and a half inches square at its base, and to taper to a height of twenty or thirty feet above the building, with a needle of platinum, or of copper and silver alloy, at its top. The base of the rod was to be plunged into the ground, and then led away from the building for fifteen feet, being finally turned down into a hole or well fifteen feet deep, and then divided into root-like ramifications, the whole being well packed round with charcoal to protect the metal from rust. In a dry soil the earth contact was to be twice the length of the one which was deemed sufficient in a wet one. It was above all things insisted upon that too great precautions could not be taken to give the lightning a ready passage into the ground, as it was chiefly upon the freedom of this passage that the efficacy of the conductor must depend. A conductor with insufficient earth contact was stigmatized as being not only inefficacious, but dangerous, because it would attract the lightning without being able to convey it to the ground.

It was further asserted in this most comprehensive and notable report that an experience of fifty years had proved buildings to be effectually protected when good conductors were placed on them. In the United States a number of conductors had been known to have been struck, but in not more than two of these cases had the buildings themselves suffered any damage. It was generally assumed, from the data then at command, that buildings which were protected by lightning-rods were not more likely to have the discharge brought down in their neighborhood on account of the presence of the rods, and it was also held that, even if they were open to such a liability, this could be of no practicable moment, because the power of a conductor to attract the lightning more frequently would, of necessity, also involve the capacity to convey it more freely to the ground. Points were spoken of as undoubtedly tending to neutralize the tension of a charged cloud. Dr. Rittenhouse was referred to as having observed in Philadelphia that the points of lightning-conductors were frequently blunted by fusion without the houses to which they were attached having been in any way injured.

The views advocated in this early code of instructions have been dwelt upon it some detail, in order that it may be seen how effectively this document laid down the broad principles of defense which are acted upon even at the present day. This instruction, after it had been stamped with the approval of the Academy of Sciences, became a sort of popular manual under the weight of this sanction. The Government gave force to the instruction by providing that it should have effect in reference to all public buildings and churches. The report also became the chief authority on the subject in most foreign lands. It likewise served the useful purpose of weakening the opposition, which still endeavored to maintain that disastrous explosions were caused by conductors, and furnished clear and precise rules for construction that were intelligible to ordinary workmen.

In the year 1854 iron was much more generally used in buildings than it had been at an earlier date, and some additional knowledge of the conditions and laws of electrical action had been acquired. The Academy, on this account, thought it well to request the Section of Physics to reconsider the lightning-rod instruction of 1823. This led to the first report, which was prepared by M. Pouillet, adopted by the Academy of Sciences on March 5, 1855, and immediately afterward issued by the Government as an additional instruction. In this document it was held that the large masses of iron employed in buildings certainly serve to attract the lightning. If two buildings of an equal size were similarly placed, the one being exclusively of stone and wood, and the other having large masses of metal in its construction, the lightning would certainly strike the latter and avoid the former, just as, when a ball of metal and a ball of wood are presented together toward a charged prime conductor of an electrical machine, it is always the former, and never the latter, which receives the spark. A dry soil, it was pointed out, does not attract the lightning. But, if, under such a soil, there occur at some depth large masses of metal, or accumulations of water, the lightning would explode through the dry earth, splitting it up as a coat of varnish is pierced by an electric spark. The line of lightning-discharge is always marked out for it beforehand, in conformity with the law of electric tension, beginning at the same instant at both the extremities of the track. The objects which are most liable to strokes of lightning are good conductors that project farthest over toward the clouds.

In the report of 1855 the occasion was used to draw attention to some instructive instances of the mechanical effects of lightning-discharges which had taken place upon the open sea. In 1827 the packet-boat New York, not at the time carrying a conductor, was struck during its passage across the ocean, and a leaden pipe, three inches in diameter and one inch thick, was fused where the discharge escaped into the sea. A chain of iron wire, one quarter of an inch in diameter and one hundred and thirty feet long, having been then hoisted up on one of the masts and trailed in the sea, was struck by a second discharge, and scattered into molten molecules and broken fragments, the bridge being set on fire, although at the time covered by a sheet of hail and a deluge of rain. The Jupiter, in the North Sea fleet, in 1854, carrying a chain of several strands of fortieth-of-an-inch brass wire, two hundred and sixty feet long, hung from the mainmast-head, and trailing seven feet into the sea, was struck, and had the chain scattered into thousands of fragments, without any damage being done to the vessel itself. A Turkish ship cruising near at the time, with a chain from the masthead which did not reach into the sea, had a hole like that which would have been made by a cannon-shot pierced through the hull near the water-line. The inference was drawn from these cases that chains, and especially small chains, were not trustworthy for the purpose of conducting discharges of lightning. The mechanical violence sustained was perceived to be due to the circumstance that the conductors provided were of a bad principle of construction. They were at the least from nine to ten times too small. Conductors provided by engineering art are intended to be struck, but struck in such a manner as to govern the lightning, and to render the heaviest strokes harmless. No case had been known of a continuous iron rod, three quarters of an inch in diameter, or with a sectional area of one and a quarter square inch, having been structurally injured. The cases alluded to were held to demonstrate that conductors must have a sufficient size and thickness of metal, and must be continuous and without defect from end to end. It was definitely settled that, in accordance with these requirements, a square iron rod used as a defense against lightning should have, at least, a diameter of nine sixteenths of an inch, and that a round rod should have a diameter of ten sixteenths of an inch.

Some modification was also made in this instruction in reference to air-terminals. It was considered that a blunt point, fashioned like the apex of a cone subtending an angle of thirty degrees, would be less liable to fusion than a sharper and more attenuated point, and that therefore it should be adopted for the upper terminal, although it might, perhaps, not exert altogether so satisfactory a neutralizing influence. The area protected by a conductor was now considered not to be so definite and certain as it was previously held to be. It was recognized that it would be less in the case of a building with a metal roof, for instance, than in other circumstances. The earth contact, it was remarked, could not be looked upon as efficacious unless it were made, through the instrumentality of sheets of water, at least as large as the area of the storm-cloud, and access to such sheets must be secured by boring both in the direction of the surface moisture and in that of the deeper soil. Chains of red copper with a square section of three eighths of an inch, and weighing a pound and three quarters per yard, were recommended for ships. Such were the principal suggestions of a practical kind that were submitted in this report. In all other particulars the provisions of the earlier instructions were substantially approved and confirmed. There was, however, one incidental remark contained in this excellent report which is deserving of the highest commendation and approval on account of its practical wisdom. This emphasized the necessity for continued and minute observation and study of the effects of thunder-storms, with a view alike to ascertain what it is that lightning spares, as well as what it strikes. It is of the utmost importance, for the advance of man's knowledge in this branch of physical investigation, that all instances of injury from lightning should be immediately examined and tested, and that all facts ascertained should be accurately described and placed upon record.

In the year 1866 the Minister of War in France became doubtful in regard to the measures which were then taken to secure powder-magazines against accident from lightning, and in consequence once again brought the matter formally under the consideration of the Academy of Sciences. It was this action of the minister which led to the third report, also drawn up by M. Pouillet, adopted by the Academy in the beginning of 1867, and shortly afterward issued under the authority of the French Government. In this report the best method of making joints in a conductor by overlapping, riveting, and soldering the contiguous ends, was pointed out, and it was urged that the underground continuation of the rod should be carried on to an adequately moist place, even if miles had to be traversed for the purpose. The increase in the number of air-terminals and the connecting them together were deemed of more consequence than the increasing the height of a smaller number. Secondary terminals were advised for every additional length of thirty-three yards of roof. The expansion of rods by heat was provided for by inserting free semicircular bands of red copper at suitable intervals, four inches of addition to the length being allowed for in every hundred yards of rod.

The example set by France in the preparation of these reports was followed for the first time in England by the appointment of a Naval Commission in 1839 to inquire into the protection of the vessels of the Royal Navy. This commission was formed in consequence of the public attention which had been drawn to the matter by Snow Harris, who stated that, within the forty years that ended in 1832, two hundred and fifty vessels had been more or less seriously injured by lightning. The commission somewhat haltingly reported that there was no harm in lightning-conductors, and that it thought the system of protection might be tried. Snow Harris thereupon introduced the plan of nailing a double set of overlapping strips of copper along the masts. After the adoption of this method the conductors were struck by lightning in several instances, but in no case did the vessels suffer any damage. This excellent system was only superseded in the end by the natural result of the introduction of iron vessels, which made the ships themselves efficient conductors in virtue of the principle of their construction. The original idea of Snow Harris was, indeed, to bring the general structure requiring defense as nearly as possible into the same non-resisting state that it would have if entirely composed of metal. He was knighted for his services in 1847, and in 1855 was employed to design the protection of the then new Houses of Parliament at Westminster, which he carried out by a modification of the plan that he had matured for the protection of the vessels of the Royal Navy. Two-inch tubes of copper, connected by solid screw plugs and coupling pieces, were affixed to all the more elevated portions of the building. The sum of £2,314 provided for the execution of this work was memorable as being the first grant made by the English Parliament for the protection of a public building against lightning.

About ten years after the erection of the lightning-conductors upon the Houses of Parliament at Westminster, it was found to be desirable to provide a similar protection for the magnificent old Hôtel de Ville at Brussels, in consequence of some damage having occurred to the principal tower of the building during a thunder-storm. The communal administration of the city had recourse to the Académie Royale des Sciences for advice in the emergency, and a commission, consisting of M. Duprez, M. Liagre, and Professor Melsens, was appointed to give a careful consideration to the matter. Professor Melsens visited Plymouth and London, to consult with Sir W. Snow Harris, and to examine the plan of defense which had been adopted for the Houses of Parliament. Shortly afterward the commission at Brussels submitted to the communal administration the famous plan of lightning-defense which has since been carried out at the Hôtel de Ville, and which has been described in the minutest detail in an illustrated work entitled "Description détaillée des Paratonnerers établis sur l'Hôtel de Ville de Bruxelles," and printed in 1865, in explanation of his views, by Professor Melsens himself.

Professor Melsens's method of defense differs in one important particular from the measures which had been recommended in the Paris instructions, and which have been most generally adopted in England. He had for some time been inclined to advocate the use of numerous rods of small size, rather than one dominant rod of more ample dimensions, whenever large buildings with numerous projecting pinnacles and gables were concerned. His view virtually is that the aim in such cases should be to throw a sort of metallic net broadcast over the building, with salient points carried up into the air at all projecting parts of the structure, and with numerous rootlets plunging down into the conducting mass of the earth beneath; and he contrived an experiment which he was in the habit of exhibiting to his visitors at the laboratory in l'École de Médecine Vétérinaire de l'État, which certainly went very far to justify the position he had taken up. He prepared a spherical case or cage of stout iron wire, and, having inclosed a small bird in this cage, he passed electric shocks through it from a battery of fifteen very large Leyden-jars, without causing either injury or inconvenience to the bird. A couple of little feathered pensioners were maintained at the laboratory for the performance of this experiment, and were subjected to the ordeal a considerable number of times, and there is no doubt could be subjected to it for any number of times, without the remotest chance that they would ever be touched by the terrific discharges that were flashed through the walls of their prison-cell in such close propinquity to them. What happened in the case of the birds in this experiment assuredly would happen also in the case of any building that was encaged in metallic rods in a similar way. No demonstration of a mere physical fact could possibly be more absolute or more complete.

The Hôtel de Ville at Brussels is a large mediæval building, inclosing in its center an open quadrangular court, and surmounted in the middle of its principal face by an elaborately pinnacled tower, 297 feet high, with a gilt statue of St. Michael at the top, standing upon a prostrate dragon and flourishing a drawn sword above his head. There are four galleries on the spire beneath the statue, and there are also six spire-crowned subordinate turrets, and three parapeted gables projecting above the roof from other parts of the building. The statue of the saint is reared upon a lead-covered cupola or platform, and Professor Melsens determined that the point of its sword should serve as the culminant point of his system of lightning-rods; but he also took the precaution of very largely re-enforcing this highest terminal by surrounding the base of the lead-covered platform at the feet of the statue with a *chevaux-de-frise* of outwardly and upwardly branching rods, constituting a radiant circle of tufted points or aigrettes. There were altogether forty-eight of these points projecting round the feet of the statue to a distance of eight feet in all directions. From these radiating aigrettes, and from the statue standing above, a series of eight iron rods were carried down along the face of the tower and the slope of the roof, through an entire length of 310 feet, to the interior court-yard. But as these rods descended along the perpendicular face of the building they were joined by other similar rods from the various subordinate turrets, pinnacles, gables, and ridges, which all had their own systems of terminal points rising up toward the sky. There were altogether 426 points projecting up from the building. An observer looking down from one of the elevated galleries of the spire took in at a glance quite a little forest of spikes bristling up into the air, which were all in direct metallic contact with the main stems of the conductors.

An even more ample provision was made for the connection of this system of conductors with the ground. The vertical rods were first collected into an iron box fixed about a yard above the ground in the inner court, and filled with molten zinc so as to unite the whole into one continuous block of metal. From the hollow of this box twenty-four iron rods, two fifths of an inch in diameter, issued, and of these a third part was carried to an iron cylinder sunk in a well, another third was connected with the iron water-mains of the town, and the remaining third was put into communication in a similar way with the gas-mains. Professor Melsens estimated that the earth contact which was established by this threefold distribution amounted altogether to 333,000 square yards of conducting communication. Iron rods were used in preference to copper in this construction on account of the cost which would have been entailed if copper had been employed for so extensive a work, and also because Professor Melsens had satisfied himself that iron has more tenacity and power of cohesion than copper when exposed to the disintegrating strain of powerful discharges of electricity. He devised a very pretty experimental proof of this, in which the discharge of a large battery of Leyden-jars was passed through a fine wire of equal dimensions throughout, but of which one half was composed of copper and the other half of iron. The iron portion was converted into a beaded, but still unbroken, strand by the discharge, but the copper part was scattered into a black impalpable powder. It is scarcely too much to say that the Hôtel de Ville at Brussels at the present day, with its lofty aigrette-defended tower, its forest of points, its net-work of rods, and its widely ramifying earth-roots, is, as far as danger from lightning is concerned, one of the best protected buildings in the world. It may safely be affirmed that it is quite as hard for the lightning to get mischievously at this building, as it is for the discharge of the Leyden battery to get at Professor Melsens's birds when they are inclosed in their iron cage.* In the heaviest of storms Professor Melsens travels about within the meshes of his system of conductors, to investigate their behavior, with the most perfect *sang-froid* and confidence. In 1866 Professor Melsens examined with great care the transmitting capacity of his system of conductors at the Hôtel de Ville, and in this final investigation he employed all the various means that are now at the command of science. He used continuous currents, instantaneous discharges, sparks from the electrical machine, from powerful batteries, and from a large Ruhmkorff coil, and with all he found that the conductibility of his system was practically perfect.

One of the grounds upon which Professor Melsens adopts his system of multiple rods is the circumstance that an electrical discharge diffuses itself through all the branches of a multifold conductor in proportion to the resistance which is offered by each part, and that it does not all concentrate itself into the shortest and most open path. He has devised some very ingenious experiments for proving this position, and has been able to show the sixty-thousandth part of a discharge passing by a very narrow and roundabout path, when a broad and direct one was open, and traversed by the larger proportions of the discharge. He brought this part of his subject under the notice of the Academy of Sciences of Belgium in a special note, which was printed in their "Bulletins" in 1875.—*Edinburgh Review.*

* M. de Fonvielle says of this plan of defense that Professor Melsens does not leave the lightning a gap that it can get through.

CHINESE CORONERS' INQUESTS.

THE method of conducting coroners' inquests in China seems admirably adapted to facilitate the escape of criminals. The feeling of the country is abhorrent to dissections, and magistrates, consequently, find the prosecution of their inquiries attended with great embarrassments, unless the case is of the plainest character. The lawmakers, however, have always, from the earliest times, recognized the importance of human life by directing that an inquest be made in every case of sudden death. A number of books have been prepared, containing the instructions needed by the magistrate in the performance of this part of his duties. The best known of these collections was published in the thirteenth century, by the direction of the officers of the Bureau of Penalties, and is a kind of official manual for the inquiring magistrate. It is called the "Se Yen Luh," or treatise on the redress of wrongs. In it is expounded the whole system of legal medicine in use among the Chinese. A few extracts from it will be of interest.

The first advice given in the "Se Yen Luh" is that the magistrate must be sure he has a dead body before he issues his order for the inquest. The reason given to make this advice seem pertinent is hardly less curious than the advice itself. "It sometimes happens," says the manual, "that unscrupulous sharpers demand an inquest on an imaginary deceased for the sole purpose of extorting money from the person they will denounce as the author of the death; and the latter, in fear of falling into the claws of the law, readily pays all that is required of him, in order to arrest the process." The officer then, having assured himself that there is a real case, goes to the spot, taking with him a good provision of onions, red pepper, white plums, and vinegar, articles that he will almost certainly have use for. If death has taken place recently, the first step is to examine the top of the head, behind the ears, the throat, and other vital parts, for marks of a sharp instrument. If this examination does not reveal the cause of death, the friends and neighbors of the deceased are questioned. An attentive examination is then made of the wounds.

"A sure means of fixing the date of a wound may be found by noticing the color of the bone that has been attacked. If the wound is recent and slight, the bone will be red; if old and severe, the color will be dark blue. It is, however, necessary to be assured that the color is real, and has not been applied so as to square with the deposition of the relatives. A red color may be given to a bone by staining it with a composition of saffron, pine-wood, black plums, alum, and boiling vinegar; and green alum or gall-nuts mixed with vinegar will give a dark-blue or black tint; but the counterfeit is generally betrayed by the absence of luster. A false wound may also be made on a body with bamboo-coals, but such wounds are always of little depth and soft. If birch-bark has been used for the burning, the flesh is black and soft, and the edges of the wound are livid. Burning with paper produces a wound like a fist-blow ; but a red and burned spot may be remarked around the wound, while the flesh within appears yellowish and tumefied, but without consistence. A true wound can also be recognized by the clear color of the surrounding flesh. The edges of the wound resemble a kind of rainbow, something like rain seen at a distance, like clouds with a vague and indistinct aspect."

After having thus defined the characteristics of a wound, and the means of exposing every kind of deception, the manual passes to the consideration of the motives for crime. "Murders," it says, "are rarely premeditated ; they are sometimes the consequence of intoxication. The magistrate," it continues, "should remember that the relatives of a wounded man may have an interest in dispatching him, so that they may demand a more considerable indemnity from the murderer. He must also inform himself, in the case of a man who was severely wounded in a brawl, whether he was honestly taken care of. In case of death, examine the body carefully from head to foot ; see whether the ears have been pulled and torn, whether the nostrils have been hurt, whether the lips are open or closed, count the teeth, inspect the cheeks, carefully feel the limbs to the finger-nails and toe-nails. If the coroner can not find a visible mark of a wound, he should pour on the part vinegar with its dregs, and then put a piece of oiled, transparent cloth between the sun and the body, and look carefully. If nothing appears, let him make another trial, with powdered white plums added to the vinegar. If this, too, fails, he should prepare a cake of white plums, red pepper, onions, salt, and vinegar, and apply it boiling hot on the part of the body where the wound ought to be. An attentive examination having been made of the body, and the marks of wounds on the skin, their shape, size, and position having been noted, death should be attributed to the wound that is found in the most vulnerable spot."

It is one of the curious features of this system that, if the death is due to a blow on the lower part of the abdomen, a clew to it may be obtained from the state of the roots of the teeth in men and of the gums in women. When the inquest is held over a body in so advanced a state of decomposition that nothing is left of it but the bones, a clear day is chosen, and the bones, after having been exposed to the vapor of hot vinegar, are examined through a red and transparent cloth. The blood having been coagulated in the wounded parts of the bones, they will be brought out, and the marks—red, dark blue, or black, as the case may be—will be made visible. A long and dark mark indicates a blow made by the arm ; a round mark, a blow of the fist ; a smaller mark, a kick. Extravasation of blood in the bone indicates a wound made before death. If doubts exist as to the identity of the remains, a son or grandson of the deceased is required to shed some of his blood upon it. If there is relationship, the blood will penetrate the bone, otherwise it will not. This kind of test may be compared with the ancient custom of barbarous people based upon the belief that the blood of relatives poured into the same vessel will mix, while that of strangers will remain separate. A like custom also is used in China to prove in court contested relationships; but the officer must be particularly careful that no salt or vinegar is put into the vessel, lest those substances should promote a mixture of the blood. It is believed to have been shown by experiment that men slain with a knife die with the mouth and eyes open and the hands closed, and that their skin and muscles are drawn up. If the victim has been decapitated, the muscles are tense, the skin is flabby, and the shoulders are drawn up. These features are not found when the decapitation has taken place after death. It is very important to discriminate between the effects of wounds made before or after death, for accomplished murderers seek to give their crime the appearance of a suicide.

The general aspect of the body is relied upon to give an evident indication of the state of mind in which a suicide was committed. If the teeth are clinched and the eyes are partly open, the act was done in a fit of violent passion; if the eyes are shut, the mouth open, and the teeth not clinched, the case was one of suppressed anger. If fear of punishment induced the suicide, the eyes and the mouth will be closed, and the body will have an air of repose, "for the unfortunate one regarded death as the end of his journey, as the term of rest that should disengage him from the responsibilities of life." The hands of a suicide continue soft for some time, and after a day or two the skin draws up—symptoms that are not observed in cases of murder.

In case of strangulation, which is very frequent, it is the officer's duty to inform himself with especial particularity respecting the exact position of the body, the signs on the neck, the existence or absence of the mark of the rope, the expression of the face, and a thousand other details.

The directions to be observed in cases of drowning are, on the whole, sensible, but the habit of generalizing here also leads to some strange conclusions. Thus, it has been discovered that bodies require a longer time to come to the surface of the water in the winter and the beginning of the spring than at other seasons.

With no aid from dissection, the inquests in cases of poison are, of course, very incomplete. The most usual test is to introduce into the mouth a silver needle that has been dipped in a decoction of *Gleditschia sinensis.* If, after a certain time, the needle receives a blackish tint that resists washing, poisoning is concluded to have been the cause of death. Sometimes a handful of rice is put into the mouth of the deceased and then given to a fowl, and the effect upon the bird of eating it is noticed.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF PROFESSOR J. P. LESLEY.

THE subject of this sketch, Professor J. P. LESLEY, this year President of the American Association for the Advancement of Science, was born in Philadelphia, September 17, 1819. He is of Scotch extraction, his grandfather, Peter Lesley, having emigrated from Aberdeenshire in Scotland. From his sixth to his twelfth year he was under the instruction of William Tucker, and showed a marked predilection for mathematics and geography. His father, a cabinet-maker, was an accurate draughtsman and an intelligent lover of architecture, and that he was in advance of his age in the matter of education is shown by the fact that he placed the pencil in his children's hands before they could write, and daily exercised them during the dinner-hour in the precise use of language for describing places and things, while obliging them to test the accuracy of their descriptions by drawings and sketches, which he mercilessly criticised. A good foundation was thus laid for those logical, linguistic, and artistic pursuits which young Lesley followed up throughout his academical years, and at the University of Pennsylvania, from which he graduated in 1838. The acquisition of French and German, music, painting, and the construction of toy machinery of all kinds in his father's workshop, were his recreations out of school-hours, and led him afterward into the ardent study of the classical and Oriental languages, and finally to that of the Egyptian hieroglyphics, those fossils of comparative philology, while occupied with the mechanical problems of geology, to which subject his life has been mainly devoted. From 1839 to 1841 Mr. Lesley was engaged on the Geological Survey of the State of Pennsylvania, under Professor Henry D. Rogers. Early interested in religious subjects, in the autumn of 1841 he entered the theological seminary at Princeton, New Jersey, and in 1844 was licensed as a minister by the Presbytery of Philadelphia. He devoted himself for a year or two to religious teaching among the German population of Pennsylvania, and in 1847 became the regular pastor of a Congregational church in Milton, Massachusetts; but his theological views soon underwent such expansion that he left the pulpit and settled in Philadelphia, to devote himself to work in the field of science. He was married, in 1849, to Miss Susan Lyman, of Northampton, Massachusetts.

In the spring of 1844 he sailed for Europe, and walked with knapsack and blouse through the western and southern provinces of France, through Savoy, Switzerland, and Germany to Halle, where he attended the lectures of Tholuck, Erdmann, Leo, and Ulrici, and returned home in the spring of 1845. In 1863 he was sent by the President of the Pennsylvania Railroad to examine the methods of hardening the surface of rails, and to report on the success of Bessemer's invention. In the course of this journey he visited all the iron-works where flasks had been erected in England, Belgium, the south and west of France, and in Austria. In the autumn of 1866 he sailed for Brest, by the order of his physician, and, traveling through Italy, returned to perform his duties as United States Commissioner at the opening of the Paris Exposition of 1867. After struggling with a painful illness three months, he walked through the Vosges Mountains, and remained the rest of the season at Vevay in Switzerland, and then went to Egypt as the guest of Charles Hale, the United States consul-general at that time, with whom he went up the river to the first cataract in one of the viceroy's yachts, returning to Italy, England, and the United States in the spring of 1868, but abstaining from all serious business until the end of that year.

His health slowly improved, but four years elapsed before he could do an ordinary day's work; and it has been his habit ever since to seek relaxation from business, when too long continued, by short trips to Europe. Such were made in 1872, 1874, 1876, 1878, 1880, 1882, and 1884, in each case remaining abroad only two or three weeks.

In 1872 Mr. Lesley was appointed Professor of Geology and Dean of the Faculty to the newly established scientific department of the University of Pennsylvania, and in 1874 he was made chief geologist of Pennsylvania under a new act providing for a complete geological resurvey of that State. He had, in 1842, constructed the State geological map and sections for Pennsylvania, and in 1846–'47 revised them and prepared the drawings and a large part of the text of the subsequently published report on the geology of that State. His work as a geologist has been more especially devoted to the coal formations of North America, and he is regarded as a chief authority on all questions connected therewith. His "Manual of Coal and its Topography" (1856) is esteemed alike for its classification of the Appalachian coal strata and for its illustrations of topographical geology. Most of Professor Lesley's personal field-work remains unpublished, such as his elaborate survey of the Cape Breton coal-fields in 1862–'63; his topographical and geological survey of the Broad Top coal-field, which occupied two years; his contoured map of the Kishkaminitas and Loyalhanna country in Western Pennsylvania, ordered by the Pennsylvania Railroad Company, which also occupied two years; his survey of the Tennessee coal-fields west of Knoxville, etc.

Abstracts from his reports of surveys of the iron-ore deposits of Huntingdon and Centre Counties, and of Cumberland and Franklin Counties, Pennsylvania; of the titaniferous iron-ore range of North Carolina; of the Embreeville district in East Tennessee; of the geology of Tazewell, Russell, and Wise Counties in Virginia; of coal, iron, and petroleum districts in Western Pennsylvania; and of the surface petroleums of the Sandy River country in Kentucky—were published, with maps and woodcuts, in the "Proceedings of the American

Philosophical Society" under various dates. During the last ten years his official duties as director of the State survey, involving the publication of about seventy volumes of reports, have prevented in a great measure his personal work as a geologist, and he has published nothing over his own name except prefaces and notes to these reports. But a large number of his geological papers, as above referred to, together with various essays on philological and antiquarian subjects, will be found in the "Proceedings of the American Philosophical Society."

Professor Lesley was for several years Secretary to the American Iron Association, and he has also for many years been Secretary and Librarian of the American Philosophical Society. Although a hard worker in science, he is a man of varied intellectual accomplishments, of a philosophical bent of mind, and interested in many of those higher questions which are agitating the mind of the age. In 1865 he gave a series of lectures before the Lowell Institute in Boston, which was afterward published (1868) under the title of "Man's Origin and Destiny as seen from the Platform of the Sciences." After being out of print for several years, a new edition of this work was called for, and it was revised and reissued, with six additional chapters, in 1881.

The book abounds in evidence of the author's independence and originality, and of his varied and extensive erudition. It is but just to say, however, that it was not intended as an elaborate or systematic treatise, and it is thus characterized by the author himself: "The author never contemplated anything beyond a general sketch of the present bearings of science upon the vexed question of the origin and early history of man. But the question has many subdivisions. He intended the several lectures to be separate sketches of those subdivisions of the field of discussion—mere introductions to their proper study. His views are stated, therefore, in round terms. Nothing is closely reasoned out. Much is left to the logical instinct, and more to the literary education, of the reader. Reference is everywhere made to sources of information within easy reach of all. Even the style of an essay has been avoided. The book is merely a series of familiar conversations upon the current topics of interest in the scientific world." This spirited book was noticed in Volume XX of "The Popular Science Monthly," and the following estimate was given of it: "We have gone through Mr. Lesley's book with interest and profit—pleased with its brilliant and forcible passages, which are frequent; instructed by its learning and its abounding facts, and stimulated by its incisive observations and its forcible arguments. But the work is strongly stamped with the author's individuality, and its supplementary chapters especially, fresh and breezy as they are, contain various opinions to which we find it impossible to subscribe. But, notwithstanding its faults, the work is original, helpful, and invigorating, and those who are concerned to note the drift of modern inquiry will be sure to find it serviceable."

CORRESPONDENCE.

WHAT KNOWLEDGE IS OF MOST WORTH.

Messrs. Editors:

While this discussion about the great ascendency given the study of the classics in all of our institutions of learning is going on, we beg to offer the following facts: Here we have the great University of Michigan, the pride of the State, with its fourteen hundred students, and schools of literature, science, and the arts, dentistry, law, pharmacy, music, medicine, political and sanitary science, and one can graduate and take the coveted degree of A. B., receive the commendation of his teachers, then study in a post-graduate course and receive the degrees of A. M. and Ph. D., and be an *educated fool* so far as knowing anything of elocution is concerned, or having acquired any knowledge of the structure and composition of his own body or of the laws of health.

To the credit of the university, it may be said that many courses of study are offered and a wide latitude given for choice; but, while four years of study in Latin and two in Greek are required in the preparatory schools and about one and a half year each in Latin and Greek in the university, nothing is required in the fitting schools or university in either elocution or physiology and hygiene, and there is absolutely no provision made in any department for teaching the former, and nothing in the latter is required or offered candidates for the degree of A. B. worthy of the name. It still seems to be considered of vastly more importance to have a smattering of Latin and Greek than to know anything about one's own body and how to care for it, or to speak well our own tongue.

Observer.

Ann Arbor, Michigan, *May* 23, 1884.

THE QUALIFICATIONS OF LEGISLATORS.

Messrs. Editors:

After reading what Herbert Spencer says of the "Sins of Legislators," I am impressed with the idea that it would be a step in the right direction to make it a necessary qualification for a member of Congress or State Legislature that he shall pass a satisfactory examination before some university board, and get a certificate showing his attainments in the studies of political economy and civil government. This would at least compel candidates for those positions to devote some time to the study of those branches—a thing they now seldom do. I see no reason why they should not be compelled to prepare themselves for their work as much as common-school teachers do now.

J. G. Malcolm.

Topeka, Kansas, *July* 1, 1884.

"AN EXPERIMENT IN PROHIBITION" FROM ANOTHER POINT OF VIEW.

Messrs. Editors:

The May number of "The Popular Science Monthly" contained an article entitled "An Experiment in Prohibition," some of the statements in which were so one-sided and inaccurate that they can not be allowed to pass without challenge. Among those statements were assertions that in the State of Vermont the prohibitory law is "an absolute dead letter"; that the returns of the United States revenue officers show that there are in that State *four hundred and forty-six* places where intoxicating liquors are sold; that "in the city of Burlington there are about threescore places where liquor is sold; and in Rutland, St. Albans, and all the larger towns, a proportional number, and in every village in the State, with the exception of a few inconsiderable hamlets, at least one such place"; that "a large proportion of the dram-shops are located upon the principal streets and there is no concealment or attempted concealment of the illegal traffic conducted within them"; and that prosecutions of liquor-sellers, on whom persons arrested for intoxication have disclosed, are "very common," but are confined to "the lowest class of liquor-dealers" and are "invariably for a first offense."

Two of these statements contradict each other. If prosecutions, though only for first offenses and of the lowest class of liquor-dealers, are "very common," it can not be correct to say that the law is an absolute dead letter. Most certainly it is *not* an absolute dead letter.

The statement of the number of places in Vermont where intoxicating liquors are sold was obtained from a newspaper compilation, from the returns of the United States Collector of Internal Revenue for the year ending April, 1883. The same returns show that, of the 446 persons paying the United States tax as dealers in intoxicating liquors, about three hundred were druggists, who must use, and keep, and sell, alcohol and spirits for purposes recognized as legitimate. While some of these undoubtedly sell liquors to a greater or less extent for other than "medicinal, mechanical, and chemical purposes," their shops can not, as a class, be called "dram-shops"—and many of them guard their sales rigidly. The 446 also include the large manufacturing and wholesale druggists, dealing in alcohol and spirits in large amounts in their trade, yet who are so far from being keepers of "dram-shops," that not only do they not sell spirits to be drunk on the spot, but no one not in the trade, high or low, can obtain alcohol or liquor from them in any quantity, large or small, for individual use, or even for cooking or other family purposes. The 446 include the hotels, some of which have no bars, and are careful how they sell to any but their guests. It is to be remembered also that the man who opened a saloon, sold whisky on the sly, and was visited by the United States revenue officer and compelled to take out a license, was included among the 446, although his alcoholic stock in trade may have been seized next day by the sheriff, and himself sent to the house of correction. These deductions would reduce the number of "dram-shops," properly so called, to a smaller number in proportion to population than in any other civilized community of equal numbers, with the possible exception of the State of Maine.

But if all concerns paying the United States tax were to be called dram-shops, then it is to be noted that the number is much smaller in Vermont in proportion to population than in any State which licenses the sale of liquors. Thus in Massachusetts, which has a "rigid license law," 8,476 persons held United States licenses to sell liquor last year, being one to every 202 of the population. In Connecticut 3,357 persons paid the United States tax, being one to every 187 of the population. In Vermont it appears that 446 paid the United States tax, being one to 744! In other words, more than *three times* as many persons were selling liquor in Massachusetts, and four times as many in Connecticut, in proportion to population, as in Vermont! And, could the amount of liquors sold where the dealer is free to advertise his business and sell all he can be compared with the amount sold where the traffic is under the ban of a prohibitory law, it would doubtless be found that each United States license in Massachusetts, Connecticut, New York, or any other non-prohibitory State, represents a vastly greater sale of liquors than in Vermont.

It is to be noted, further, that the number of persons paying the United States tax in Vermont shows a noticeable decrease in the last ten years, the number returned for the year 1873 being 684. Here appears to be a decrease of some thirty-five per cent in ten years. During the same period the number of United States licenses issued in Maine increased by 78; in Massachusetts, by 208; in Connecticut, by 573; in Rhode Island, by 436. *Something*, evidently, is checking the liquor-traffic in Vermont to a considerable extent, and the universal and strong opposition to the law, on the part of those who consider it to be for their interest to have more rather than less intoxicating drinks consumed, shows clearly that *they* attribute a good part of the restriction to the prohibitory law.

The number of places where liquor is sold in Burlington is overstated. The number in April, 1883, was not threescore, but 49.

It is not the fact that in every village there is at least one such place. Many Vermont villages have no such place, and have not had for twenty years. In more than half of the towns of Vermont, the United States revenue collectors could not find, in the year ending April 12, 1883, any one selling liquor. There are 240 towns in Vermont, and in 127 of these no drug-store, hotel, or dram-shop was found that could be required to pay the United States tax. The statement that there is no concealment or attempted concealment of such illegal traffic as is conducted in the State could hardly be made wider of the truth. As a general thing, the traffic is everywhere concealed from public view. No placard, sign, advertisement, or open bar attracts men to drink. The liquors kept for sale are kept under lock and key, or in dark rooms or cellars; and even then seizures are frequent and fines numerous, and often ruinous to the business, and prosecutions are by no means confined to first offenses, or to liquor-dealers of the lowest class. The law is one which enables the citizens of any town to do what they choose as regards illegal traffic in liquor. If they choose, they can banish it. If they do not care to banish it, they can restrict it, if they will, to almost any extent. In point of fact, in Vermont, as a whole, the law exercises a steady and increasing pressure upon the illegal traffic, and makes it a very risky and disreputable business. To this extent the law is no failure.

Prohibition has been for over thirty years the settled policy of Vermont. The law has been changed by successive Legislatures only to perfect and strengthen it. As the State is admitted to be "a moral and God-fearing community," and its people are not considered specially lacking in intelligence, the fair inference from such extraordinary support and popularity would seem to be that the prohibitory system must have merits for a community like that of Vermont, and that it must have measurably answered its purpose. It is idle to say that this support and popularity are factitious. Bubbles do not last for generations. It might be possible, with effort enough, to manufacture a sudden sentiment for such a system, that might last for a year or two. But it is safe to say that a measure like this, which stands firm year after year, and decade after decade, against the bitter opposition of an elsewhere powerful interest, among a not particularly visionary people, among a people, in fact, of more than the average independence of judgment and practical hard common sense, must amount to something. This inference I assert to be a correct one. The people of Vermont have sustained the prohibitory law for over thirty years, and will continue to sustain it—not as a lovely theory or a "barren ideality," not as a panacea for all social evils, not as necessarily the best thing for all States and all communities, in their existing conditions; but as the system which is better for *them* than any other they know of; as a system which in spite of the hindrances, defects, and perversities which largely obstruct all moral effort and must be expected, especially, to hinder an effort to curb the gratification of an appetite as general and powerful as that for strong drink, does practically, here in Vermont, restrict the liquor-traffic to a greater extent, and so proves itself a better ally to moral effort to resist intemperance than any other method of restriction they have ever tried, or seen tried elsewhere.

George Grenville Benedict.

EDITOR'S TABLE.

MEETING OF THE AMERICAN SCIENTIFIC ASSOCIATION.

THE thirty-third meeting of the American Association for the Advancement of Science will take place this year at Philadelphia, beginning on Thursday, the 4th of September, under the presidency of Professor J. P. Lesley, Chief of the Geological Survey of Pennsylvania. In order to allow an interchange of courtesies between the American and the British Associations, the latter of which meets the previous week in Montreal, the American meeting is put at a later date than usual. The Council of the British Association has invited the fellows of the American Association to join in the meeting at Montreal on the footing of honorary members; and the American Association and the local committee of Philadelphia have invited the members of the British Association and their relatives who may be with them to take part in the Philadelphia meeting. Invitations have been sent to the leading scientific societies abroad, asking them to send delegations to the Philadelphia meeting, so that it is expected to be largely international in its character, and it is likely that steps will be taken to form an International Scientific Association. An International Electrical Exhibition, under the auspices of the Franklin Institute, will be open at the same time, and the American Institute of Mining Engineers and the Pennsylvania State Agricultural Society will hold sessions at Philadelphia during the same week. On various accounts, therefore, the occasion will be one of unusual interest, and the meeting will probably be fully attended, while the large local committee of Philadelphia may be trusted to make every arrangement possible to conduce to the pleasure and profit of the visitors.

THE BRITISH ASSOCIATION—INTERNATIONAL SCIENCE.

The British Association for the Advancement of Science holds its fifty-fourth annual meeting this year at Montreal, commencing on the 27th of August under the presidency of Professor Lord Rayleigh, of the University of Cambridge. This is, perhaps, the largest and most powerful scientific society in the world, and its coming from Europe to America is a new departure in its history, of such considerable significance that we may profitably give some attention to it.

The British Association was established in 1831, over half a century ago, and held its first meeting in the city of York. It came into existence in obedience to a growing demand for what may be termed scientific expansion, or a desire to increase the cultivation and augment the influence of science by bringing larger portions of the community within reach of scientific facilities, and making more familiar the intercourse of men devoted to scientific labors. Numerous societies already existed for the promotion of research, both special and general, but they were local in their operations, while their members met their fellow-workers in different cities but rarely, and multitudes of educated people were not brought within the circle of scientific influence. Yet the number of these societies attested that the work of scientific investigation had taken deep root. Scientific knowledge had become greatly extended, and this led, by the inevitable course of things, to the necessity of more efficient and comprehensive organization for its further increase and diffusion. With the growing sense of the general importance, and the augmenting influence of science in society, there was a strengthening desire to share its work and its advantages, and this naturally led to association upon a new basis, better adapted to the new conditions. The British Association, instead of taking root in one locality, was constituted as a migratory body that should hold its annual sessions, of a week's duration, successively in the different cities of the United Kingdom. It was announced at the first meeting that, while contemplating no interference with the ground occupied by other institutions, its objects shall be "to give a stronger impulse and a more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire, with one another and with foreign philosophers—to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress."

These objects of the Association have been well fulfilled in its history. It has been a power in England for the accomplishment of the purposes designated. It has attracted multitudes of capable men to devote themselves to scientific pursuits. It has systematized and promoted observation and research in various fields, and has lent efficient pecuniary assistance to many workers who were without the means for investigation. Its career has been coincident with the highest scientific activity in all civilized countries, and it has lent its powerful co-operation in bringing out many of the grand scientific results that will make the last half-century memorable in scientific history. The British Association has, moreover, been administered from the beginning in a liberal spirit and with enlarged views. While mainly devoted to the extension and the improvement of scientific knowledge, it has never been afraid to express its sympathy with the popular aspects of scientific questions, and it has wisely lent its influence for the encouragement and general promotion of scientific education. Perhaps no higher testimony could be afforded of the excellence of its plan, the value of its labors, and its adaptation to the requirements of the period, than the fact that it has been successfully imitated both in the United States and in different Continental countries.

The coming of this body across the Atlantic to hold one of its annual sessions in Montreal, while quite in accordance with its established policy of enlarging the field of scientific influence, is such a signal stroke of expansion as fitly to make an epoch in its beneficent career. It does not, indeed, overpass the limits of the British Empire, but it migrates to a new continent, and if not to a foreign, at least to a distant and a different people. It seems to us, therefore, that, to reach the highest utility of the occasion, it should be be made subservient to the more systematic organization of international agencies for the promotion of science. While in itself but a transient event, it is nevertheless a fitting opportunity to initiate something permanent, that shall mark the stage at which we have arrived in the growth of what may be called the international scientific consciousness of the world. Something, indeed, has already been accomplished in this important direction. That large division of the students of Nature, the medical profession, has entered into extensive co-operation on an international scale for the advancement of its interests. The International Medical Congress meets once in three years, each time in a new country, and all who have participated in its proceedings testify to the reality, the extent, and the value of the results attained. There is no reason why similar advantages may not be derived from an international association of scientists devoted to the promotion of the general objects which they have in view. We are glad to observe, as remarked above in referring to the American Association, that steps are being taken to organize such a body on an international basis. It will be but a further and natural development of the policy of the British and American Associations within their respective countries. There is a large field of labor that would especially belong to such a body, for hitherto science has been to no small degree hampered and impeded by the disagreements and conflicts that have arisen out of its limited and national pursuit. An international congress of scientists would be the proper body to promote the adoption of common standards of time, of measurements of all kinds, of biological and geological nomenclatures, of common systems of recording observations and statistics, and the policy of scientific undertakings which require international co-operation, and it would have many things to do which there is no association at present entitled to undertake. The same important advantages of increased personal intercourse among the cultivators of science, to which the existing associations have been tributary in their respective countries, would then be secured on a still wider scale. Nothing is more important than the bringing of scientific men, who are separated by distance and rarely see each other, into personal contact and acquaintance, to gain that intimate understanding of each other which can only come from personal discussion; and this is the more necessary where men are habitually separated by the differences of nationality. There are many reasons why such an organization should be established; the time has come for it, and the present is an especially favorable time for carrying it out. The large attendance of foreign scientists at Montreal is to be followed by the meeting of the American Association in Philadelphia, and many of the foreign *savants* will be present at that meeting. The circumstances are auspicious for taking this new step which, if taken, will undoubtedly be productive of lasting and world-wide advantage in this great field of labor.

But we must not lose sight of the loftier lesson that is so happily illustrated in the coming of this most powerful of scientific organizations to the New World, and which is well calculated to incite to further action in this important direction. What concerns us most is the exemplification it affords of the gathering strength of the great scientific movement in this age. The visit is made in obedience to that development of scientific influence by which it has now become the great leading force of civilization itself. We hear much of the *advancement* of science, as if it were but a movement in one direction; but we must not forget that with progress there has also been a vast widening of the scope of scientific influence and activity. The movement is one of enlargement of ideas, and it is only when we regard the different sciences as fusing into the most vital inter-connections, and reorganizing human knowledge, that we can begin to understand the import of the epoch upon which we have entered, and appreciate the full meaning of these demonstrations of enlarged operation in the scientific agencies of the period. It was inevitable, from the very nature of things, that science should overleap its past limitations and pass to the stage of international comprehensiveness; but, fully to comprehend this, we must remember that it represents a new epoch of thought, and promises a new education for mankind. The dominant ideas of the past have been confining and restrictive. National feelings are diverse and antagonizing; religions are hostile, and politics local and exclusive; but science is as universal as Nature, its devotees are one in spirit and in purpose, and it is undoubtedly the supreme unifying element of the modern social state. It studies phenomena of every kind, and is equally at home in every place. Its perpetual aim is the dispassionate consideration of facts, and the generalization of wider and more comprehensive truths. Eschewing all narrowness and prejudice, by the very nature of its discipline it tends to break down factitious limitations, it cultivates the spirit of large-mindedness, and is the great teacher of toleration, liberality, and catholicity. By leading to profounder agreements, by awakening broader sympathies, and making possible more harmonious co-operations in the further progress of civilization, the extension of science is full of hopeful encouragement for the best interests of mankind. Under its influence men emerge into the light of new intellectual relations, new opportunities, and new responsibilities. The elevated sentiments by which men of science are more and more animated were thus eloquently expressed by one of the distinguished presidents of the British Association, Sir John Herschel. He said: "Let selfish interests divide the worldly, let jealousies torment the envious; we breathe a purer empyrean. The common pursuit of truth is of itself a brotherhood. In these meetings we have a source of delight which draws us together, and inspires us with a sense of unity. That astronomers should congregate to talk of stars and planets; chemists, of atoms; geologists, of strata, is natural enough; but what is there, equally pervading all, which causes their hearts to burn within them for mutual unbosoming? Surely the answer of each and all—the chemist, the astronomer, the physiologist, the electrician, the biologist, the geologist—all with one accord, and each in the language of his own science, would answer, not only the wonderful works of God, and the delight their disclosure affords, but the privilege he feels to have aided in the disclosure. We are further led to look onward through the vista of time with chastened assurance that Science has still other and nobler work to do than any she has yet attempted."

THE C LLEGE FETICH ONCE MORE.

The annual season of college commencements and commemorations is past, and it brought with it the customary laudations of classical study in unusual profusion. The stir of the subject by last year's discussions aroused the friends of Latin and Greek, and they seized the favorable opportunities to expatiate with renewed unction upon the unrivaled educational value and importance of these immortal languages. Professor Jebb, the accomplished Greek scholar, formerly of Cambridge, but now of Glasgow University, was brought over to address the Phi Beta Kappa Society of Harvard, in the hope, no doubt, that he would contribute something to undo the mischievous last year's work of Mr. Charles Francis Adams, Jr., in his address before the same body. Professor Jebb, however, gave rise to some disappointment by not taking the *rôle* of a champion of the study of Greek, but contented himself with drawing an interesting parallel between some of the intellectual activities of the Greeks and those of our own age.

But if Professor Jebb declined to take up the defense of Greek, now so vigorously assailed as well in his own country as in ours, there are other able men who will not blink the glare of the controversy. Among these is Professor Bonamy Price, of Oxford, who, although a teacher of political economy, takes up the cudgels with great vigor for the classical languages. He contributes the leading article to the "Princeton Review" for July, under the title of "What is Education?" The first part of his paper returns an excellent and an unexceptionable answer to his question-title. He denounces the prevailing propensity to "cram" in unsparing terms; he eulogizes *viva voce* in teaching, and thus sums up: "The aim and task of education—independently of the value of the knowledge obtained for moral or or any other purposes—is to cultivate the powers of the understanding, to strengthen and enlarge them, to show how they are to be used in mastering any subject. It seeks to train the young pupil how to use his brain, how to determine and examine for himself the questions put before him, how to handle his mind as a tool, and thus to realize the very purposes for which that mind was given him—in a word, to teach him how to think."

As to the general means of securing this object the suggestions of Professor Price are sound. He says: "Now, what is the educational process to be adopted for accomplishing this great object of teaching a boy how to think? Not, certainly, to set him to read well-written and learned books, to store up their contents in his memory, and then to pour them out at examination. Nor will this great end be reached by learned addresses from tutors, carefully gathered up in notes by the pupils and then followed up by examinations which simply test the attention and the accuracy of the students. This is cram—nothing better. . . . The answer is not difficult; indeed, it may be called obvious; yet how little is it perceived or valued at the present hour even in our most distinguished institutions of education! Its secret lies in skillful questioning by the teacher, in power to make the pupil discover for himself the facts and truths to be gathered up at each place. . . . The work of the teacher is to direct the attention of the student to the facts lying before him, to stimulate his inquiry into the relations which they bear toward each other, what difficulties they present, how they are to be cleared away by thought, what new truths they reveal. To make the pupil find out for himself the answer to be given to each question, as it arises, is the very essence of real education. . . . The pupil's mind is ever kept thinking, putting together, and discovering. The knowledge won is in no small degree his own acquisition, the product of his own intelligence, his own brain. He is incessantly learning how to use the faculties with which his mind is endowed, and with their help, *guided but not told by the teacher*, to gather up the understanding of the subject to be explored."

But now comes the question, What are the studies best adapted to attain this ideal of education? To this Professor Price devotes the second part of his paper; and he here conspicuously illustrates what has been shown a thousand times before, how an elaborate classical culture can so pervert the mind and bias the judgment that the most weighty considerations are absolutely unrecognized. To the broad question what subjects of study are best suited to cultivate, strengthen, and enlarge the powers of the understanding, Professor Price answers: "For value and power it may safely be asserted the study of the Greek and Latin languages stands pre-eminently the first. Greek, above all, has no equal in educating force; it is the greatest, the most productive tool for developing the minds of the young known to man."

But if, now, we ask how these sovereign advantages are to be secured, or in what does this incomparable virtue of Greek for educational purposes consist, the reply is, that through the mastery of this language the student's mind is brought into close relation with the minds of the greatest men, Plato and Aristotle, Virgil and Æschylus, Thucydides and Demosthenes, Homer and, "above all, Saint Paul"—especially in the Epistle to the Romans.

Professor Price's argument here consists merely of fresh and vivid eulogies of the old Greek masters, and declarations that they are wonderfully fitted to quicken and elevate the minds of students. He maintains that they are excellent instruments of discipline, and this probably but few dispute. His proposition is that Greek and Latin are "pre-eminently the first" among the instrumentalities of mental development; but he neither proves nor attempts to prove it. The idea of "pre-eminence" is relative; it implies superiority to something else; and the argument, to be good for anything, must state the claims and prove the inferiority of that something which is assumed to be inferior. The acquisition of Greek gives a discipline in the study of languages, and that may be the best of all languages for the purpose. The mastery of Greek literature gives a literary training, and it may be the best of all literatures for the purpose. But that is not at all the question. The question is as to the "pre-eminence" of language and literary discipline over any other kind of discipline. The real issue, the issue that has arisen in modern times, is between language and literature on the one hand and science-studies on the other, as instruments of mental development. This essential issue Professor Price does not take up. He does not even recognize the existence of such a thing as a mental discipline gained by the study of science. He refers indeed to science, in the usual classical spirit, as giving useful knowledge to "the lower classes," who have to work for a living. "In the lower classes of life, useful knowledge, knowledge that fits the learner to carry on some special business from which a livelihood is to be obtained, is the object most desired. . . . A little boy may easily be made to understand how a plant grows, how it picks up some substances from the sun and air, or under or from the ground, how it decomposes these substances and extracts from them the parts which they can apply to their own growth." Are we to infer from this slovenly sentence, equally false to the facts of science and the rules of grammar, that an accomplished Oxford classicist holds himself under no obligation to write decent English when coupling the study of science with vulgar laboring people?

Notwithstanding Professor Price ignores it, yet Greek and Latin are on trial before the world under indictment for the fatal deficiency of their educational discipline! They are arraigned as in this respect fundamentally defective because they leave in total neglect some of the most essential powers of the mind. What valid claim has a system of mental cultivation, in this age, which gives no more heed to the important faculty of observation in the youthful mind than if it had no existence; which neglects the study of Nature, and makes no provision for cultivated mental intercourse with the most immediate objects of human experience; which fails to use the great living problems of human interest with which intelligent beings are vitally concerned, as means for the systematic discipline of the reason and the judgment in preparation for the responsible work of life? Here are the opportunities and the urgent needs, and here the possibility of that varied, methodic, and persistent exercise of the mental faculties which gives them their soundest and most symmetrical discipline. Modern studies have become the rivals of ancient studies, and the discipline of science the rival of classical discipline. The discipline of science is superior to lingual and literary discipline because it involves all the mental processes, because it takes effect upon the realities of experience, because it is a discipline in the pursuit of truth, because it is a preparation for practical life-work, because it uses the most perfected knowledge as its means of culture, and because it brings the mind into intimate and intelligent relation with the system of natural things, which it is the first interest as it is also the highest pleasure of man to understand.

A CORRECTION.

An article contributed to the "North American Review" for August, by Mr. George J. Romanes, an English author, opens with the following passage: "A few months ago I published a work entitled 'Mental Evolution in Animals,' in which I attempted to trace as carefully and thoroughly as I was able the principles which have probably been concerned in the development of mind among the lower animals. This work, I believe, has already been reprinted in America; and seeing that, under the existing state of matters with reference to copyright, an author on this side of the Atlantic is precluded from securing any pecuniary interest in the sale of his work upon the other side, I am free to allude to this book as constituting the basis of the present paper."

We read this statement with some surprise. Had Mr. Romanes said, "The American people deny my ownership of the book that I have made and which they reprint, and I therefore hold myself absolved from recognizing anybody's ownership of the reprint," his position would be intelligible. But, when he says he proposes to make use of its contents as he pleases because he "is precluded from securing any pecuniary interest in the sale of his work" in this country, his statement creates a false impression, and one which we are personally concerned to correct. Mr. Romanes contributed "Animal Intelligence" to the "International Scientific Series," a project which was undertaken expressly in the pecuniary interest of scientific authors; and on all sales of this book the stipulated royalty is placed to his credit, to be drawn by his English publishers. It was intended, as we understand, at first to include the "Mental Evolution in Animals" in the "Series" also; but, although this was not done, it is to be paid for under arrangement by the American publishers at the same rate. When the profits are earned by the sale of the volume, Mr. Romanes will be entitled to them by contract, and he thus stands upon the same practical footing as an American author.

LITERARY NOTICES.

Outlines of Psychology, with Special Reference to the Theory of Education. By James Sully, author of "Illusions," etc. New York: D. Appleton & Co. Pp. 711. Price, $3.

Mr. Sully has brought to the preparation of this comprehensive work unusual accomplishments for the task. He is well known as an indefatigable student of mental science, and his numerous contributions to the leading English periodicals, on advanced pyschological questions, give him a high rank both as an original inquirer and an attractive and successful writer upon these subjects. He is the author of several systematic works, one of which, on "Illusions," prepared for the "International Scientific Series," has been republished in this country. Mr. Sully is thoroughly familiar with the results and methods of the modern English school of psychological thought, and he has also pursued his studies in Germany under the ablest masters, so that he is well equipped for dealing with the subject in the light of the most advanced views. It may be added that he is no partisan and no extremist, but writes with care, moderation, and judicial fairness, taking impartial advantage of the best that has been gained by the various schools of investigation. Recognizing the importance of introspection as an instrument of psychological observation and analysis, he supplements it by the physiological study of the nervous conditions and concomitants of mind. His general point of view is that of evolution, and his capacity of handling his subject by this method may be inferred from the fact that he was chosen in conjunction with Professor Huxley to write the elaborate article on "Evolution" for the present edition of the "Encyclopædia Britannica." It may be added that his book is one of great clearness, and will prove of unusual interest to the general reader, while as a text-book of mental science it undoubtedly has merits superior to any other treatise now before the public.

We pointed out editorially, not long ago, in an article entitled "The Progress of Mental Science," the important results that have flowed from the widening of the method in mental studies by which metaphysical speculation has been supplemented by the knowledge of mind, as physiologically conditioned, and we showed that the benefits of this change are conspicuous in the practical results obtained. The time has come when the validity of the science of mind is to be largely tested by such practical applications, and we have noted with gratification that Mr. Sully accepts this view, and has constructed his treatise with reference to it. While the work is, of course, mainly a strict and systematic treatise on psychological science, presenting its elements in their due proportions, yet the author throughout has developed its practical bearings upon the art of education. In regard to this feature of his work, the author makes the following remarks in his introduction:

> Finally, I have sought to give a practical turn to the exposition, by bringing out the bearings of the subject on the conduct and cultivation of the mind. With this object I have ventured to encroach here and there on the territory of logic, æsthetics, and ethics—that is to say, the practical sciences which aim at the regulation of the mental processes. Further, I have added special sections in a separate type, dealing with the bearing of the science of education.

> I would fain think that these practical applications will not be without interest to all classes of readers; for everybody is at least called on to educate his own mind, and most people have something to do with educating the minds of others as well. With respect more especially to professional teachers, I trust that these portions of my volume may serve to establish the proposition that mental science is capable of supplying those truths which are needed for an intelligent and reflective carrying out of educational work. I may, perhaps, assume that modern pedagogics has adopted the idea that education is concerned not simply with instruction or communicating knowledge, but with the training of faculty. And it seems a necessary corollary from this enlarged view of education that it should directly connect itself with the science which examines into the faculties, determines the manner and the conditions of their working, and lastly traces the order of their development.

This characteristic of Mr. Sully's work we hold to be of especial importance; for, although no great amount of space is given to the subject of education, yet the whole course of the exposition is so tributary to it that what is stated has a high and peculiar value. The lessons for the teacher are derived immediately from the latest and broadest views on the subject of mind. The time has gone by when the old modes of studying this subject are satisfactory. That a teacher has read up a lot of metaphysical treatises and become familiar with their subtile dialectics and old terminology is no evidence whatever of competency to guide the processes of mental development. Rather is it a disqualification, for a mind saturated with the antiquated mental philosophy is certain to be prejudiced against the new and better methods. It is indisputable that there has been a radical change and a vast improvement in the study of mind, within recent years, and the teacher who has not benefited by that improvement is fundamentally deficient in the preparation for his work. The author of this treatise has therefore done a most important service in dealing with the subject of education, in connection with his broad presentation of the present state of knowledge upon the subject of psychological science.

The True Theory of the Sun. By Thomas Bassnett. New York: G. P. Putnam's Sons. Pp. 264, with Plate. Price, $3.

Mr. Bassnett is the author of the "Outlines of a Mechanical Theory of Storms" which he published some thirty years ago, and the substance of which he presented before the American Association, to have its principle found inadequate by the committee to whom the subject was referred. For this treatment and for other evidences of lack of appreciation which he has received at the hands of men of science, he is still grieved. He continues to press his theory, and now expands it and extends it to solar storms and their influence. It presupposes vortexes in the ethereal medium in connection with the motions of the earth and the planets, and the exertion by the moon of disturbing influences upon the terrestrial vortexes, producing electrical action and storms. The author believes that he has ascertained the law of the disturbances, and can accurately predict the occurrence of storms in any part of the earth. A common origin in similar phenomena is hypothecated for solar spots and the corona and for atmospheric changes and cyclones. Those may test the theory who are able to master it and wish to try the experiment; four tables are given for computing the maximum and minimum epochs of solar activity and "the passage in time and place of the chief disturbances from the equator to the poles in both hemispheres."

The Consolations of Science; or, Contributions from Science to the Hope of Immortality, and Kindred Themes. By Jacob Straub. With an Introduction by Hiram W. Thomas, D. D. Chicago: The Colegrove Book Company. Pp. 435. Price, $2.

This work comes to us very highly commended for its admirable spirit, its masterly criticism, and its exalting views, by such men of thought as President Porter, Rev. Robert Collyer, and Professor Swing, and we have no doubt that many people will enjoy it, and find themselves helped and encouraged in their religious aspirations by the views it presents. The author has mastered the tendencies of modern science, and finds that the profoundest lesson to be drawn from them is that the most real, lasting, and powerful things are invisible, and on the basis of all that science has revealed he claims to gain strong confirmation of the belief in a future state of existence, and the immortality of conscious being. But while it is no doubt possible to appeal in this way to science for consoling encouragements in regard to the future and everlasting life, it can only be by great freedom and boldness of speculation that reassuring responses can be returned. It is not in the power of science to prove the truth of immortality. Science can only deal with the phenomena of time and experience, and whatever transcends these must be left to the sphere of faith.

Government Revenue, especially the American System: an Argument for Industrial Freedom against the Fallacies of Free Trade. By Ellis H. Roberts. Boston: Houghton, Mifflin & Co. Pp. 389. Price, $1.50.

This volume has a claim to the attention of readers, first, because of the information which it contains on the subject of government revenue; next, because it is a hot polemic in behalf of protection, and against free trade, full of ingenious arguments; and, lastly, because its contents have been delivered as lectures before the students of Cornell University and of Hamilton College.

The book abounds with facts upon financial and economical subjects, indicating the author's wide and critical reading. But facts with him are valuable only as tributary to theories. Accordingly, he argues broadly on the basis of his multitudinous data against the freedom of commerce, and in favor of the protective system, and the political regulation of the industries of the country.

The delivery of his views before college classes was by no means a bad idea. Something is, indeed, to be said in favor of limiting collegiate study to subjects which are settled in their principles; and political economy has long been recognized as fitted for college study because it involved established truths of great public importance. But among these have been the principles of free trade, so that these institutions have become centers of propagandism of this doctrine. That the advocates of protection should not be satisfied with this, is only natural; but, instead of trying to suppress the objectionable teachings, they have more wisely attempted, as in this case, to correct the evil by presenting the claims of the opposite system. The difficulty is, how far this policy can be carried. Will the authorities of Cornell University permit Mr. Ignatius Donnelly, author of "Ragnarok," to go before its classes and present the other side of the accredited geology? Mr. Donnelly's case is of the same kind, and quite as strong as Mr. Roberts's.

Mr. Roberts's theme is, "The Subject of Revenue, especially the getting of Money for the Public Treasury." It "relates to filling the Treasury, and not to emptying it; we are to find out about the income of states"; and this "will bring us immediately upon the relations of government to the people." We infer, from looking over his book, what seems to be confirmed by all history, that it is the great, primary, universal business of all government to get money out of the people; and the question is, as to the easiest and most effectual way of accomplishing this object. Mr. Roberts maintains, and we think he proves, that the most successful way of extracting money from the people is not openly to demand it, as something honestly due to government, but by the indirect process of levying exactions upon commerce. Mr. Roberts shows that this is the ancient, the favorite, and most extensively employed method; and, if the object of government be solely to raise money, without regard to any other consideration, beyond doubt the taxation of commerce is the best method. But the taxation of commerce is a burden upon it, restricting its freedom, and disturbing the price of the commodities taxed. This consequence of the repression of foreign commerce has been utilized for the regulation of the home industries of nations by the so-called protective system, which is a natural result of the revenue system expounded by Mr. Roberts, and they are accordingly both defended together.

There is one feature of our author's argument which at this time is something of a curiosity. He calls this old system of restriction and protection, which has been a favorite with kings, tyrants, and oligarchies from the beginning for plundering the people, "the American System." Many will remember the brilliant passage in Daniel Webster's celebrated free-trade speech of 1824 (left out of Everett's edition of Webster's works), in which he exposed with merciless invective the absurdity of Henry Clay in calling the ancient policy of commercial restriction "the American System." Yet sixty years later Mr. Roberts finds this designation quite as available as ever. But, after proclaiming "the American System" on his title-page, Mr. Roberts proceeds in the very first paragraph of his first chapter to show that the policy is as old as the Pharaohs. The King of Egypt "took his tribute also from all merchants who entered his land." Among the various despotic ways of extorting money from the Egyptian people, "commerce contributed its full share by traffic in the name of the ruler, by charges on traders, and the first example of an export duty is traced to that ancient land." Not only the people, but both kings and priests, "were forbidden to use any article not produced in the country. The development of all classes of production was thus persistently fostered." The policy, it would seem, might thus be properly named the Egypto-American policy, but that our author shows that it has been substantially adopted by all governments from the time of the earliest Pharaoh to President Arthur.

Our author's reasoning upon this subject reminds us of the logic prevalent among the American people a quarter of a century ago in regard to the peculiar system of protecting the negro. It was maintained that this is best done by his enslavement, inasmuch as the enslavement of man, in one form or another, has been practiced in all communities and at all times. The restrictions upon trade and the regulation of industry by levies upon commerce are urged as having precisely this sanction, for, as Mr. Roberts says:

"No axiom of morals, no doctrine of any creed, hardly any fact in science outside of pure mathematics, has ever been so uniformly sustained by the teachings and practice, certainly not by such a consent of legislation, of mankind in all ages," as restraints upon the liberty of trade and the freedom of industry.

But Mr. Roberts evidently does not relish the idea of being ranked as an enemy of all freedom in the business affairs of the people in this country and in this age. He proclaims that men should be free to work or that they should be at liberty to produce what they like and as they like, and only be manacled when they come to dispose of their productions. He has a great deal to say about "liberty of production" and "industrial freedom." He must therefore think that men, if "let alone," and left free to exercise the largest option in the choice and pursuit of vocations, will *create* more property than if hampered and meddled with by government.

But why the same principle would not apply to the exchange of property, and why wealth would not be further augmented by the liberty of citizens to sell and buy the products of labor when and where they will, without let or hindrance, he does not explain. His concession of "the liberty of production" is, however, illusory. Commerce and industry are so bound up together that you can not fetter the former without restricting the latter. Indeed, one of the avowed purposes of repressing commerce is the coercion of production. As trade is not free if hindered or paralyzed by legislative action, so production is not free if forced by government into artificial channels, and regulated by politicians rather than left to the open competitions of private enterprise.

Six Centuries of Work and Wages. The History of English Labor. By James E. Thorold Rogers, M. P. New York: G. P. Putnam's Sons. Pp. 591. Price, $3.

In the midst of the deluge of books on social questions—labor, wages, land, co-operation and what not—most of them mere wild and worthless speculations, we turn with a sense of refreshing relief to this solid contribution to the subject from the point of view of simple historic facts. Professor Rogers is known as a political economist of wide acquirements and independent opinions, but he is so far imbued with the scientific method as to recognize that our first need is to get command of the facts of experience in a form available for the derivation of safe conclusions. Some eighteen years ago he published the first two volumes of a comprehensive "History of Agriculture and Prices," and the present volume is but a continuation of his line of studies in this general direction. The work is nothing less than a contribution to the social history of England, treated with reference to the conditions of the laboring-classes at various periods, their opportunities of labor, their rates of wages, their social privations and comforts, and all with reference to the influence of government and legislation, and the constitution of English society.

The theme is a noble one, and it is handled with great instructiveness, and with a sustained interest from the beginning to the end of the volume. It should have a place in every library, and is one of the books that must be carefully consulted by all students of social economics. The following passage, from the review of the London "Academy," exemplifies the character of the questions dealt with in Professor Rogers's work:

> It is an honest and scholarly attempt to reconstruct the social state of England in the thirteenth century, and, from that as a starting-point, to trace the changes in the position of the laboring-classes from the time when many of the peasants were slaves, and most of them in a condition not far removed from serfdom, to the crisis when, by reason of plague and famine, the laborers, "as by a stroke," became suddenly the masters of the situation. The great pestilence made labor scarce, while at the same time the bonds were loosened which tied the laborer to the land. Wages were high, and food remained cheap; and, although continual attempts were made to reduce wages by act of Parliament, it may be fairly said that "the golden age of the English laborer" continued until the change in agriculture caused by the commercial disturbance which followed the discovery of America. The flow of gold and silver to Europe led to a rise in the prices offered in the Continental markets for English hides and wool; and this turned the landlords' attention from the old arable farming in common field to the rotation of grass and grain in the mixed husbandry that enabled them to meet the demand.

Key to North American Birds. Second edition, revised to date, and entirely rewritten. By Elliott E. Coues, M. D. Boston: Estes & Lauriat, Pp. 863. Price, $10.50.

This splendid and profusely illustrated book contains, to quote from its full title, a concise account of every species of living and fossil bird at present known from the continent north of the Mexican and United States boundary, inclusive of Greenland. The account is preceded by a general ornithology, or outline of the structure and classification of birds, and a field ornithology, or manual of collecting, preparing, and preserving birds. The whole is preceded by an "Historical Preface," in which the progress of American ornithology is outlined and divided off into periods, from its beginning in the seventeenth century to the present time. The first edition of Professor Coues's "Key" appeared in 1872, in an issue which was not stereotyped, and has been long out of print. It was composed upon the same general plan, and with the design of reaching the same ends, as the present edition, but had an artificial key to assist in the reference of specimens directly to their genera, which has not been found useful enough to justify its retention. It answered its purpose well, of giving such descriptions of species as would enable the student to identify and label them with no other aid than itself afforded. It had a useful career till the issue was exhausted and no more copies could be had. During the twenty years that elapsed before the present edition was ready for the press, American ornithology had a great development. The number of distinguished species increased to nearly nine hundred; numerous treatises were published on the subject; a distinctly American school grew up, introducing important changes in nomenclature and classification; and an American Ornithologists' Union was founded, with members in all quarters of the globe. In preparing this edition, the classification and nomenclature have been modified to suit the growth of the science; the author's "Field Ornithology," published separately in 1874, has been incorporated in the volume; the outline of "Structure and Classification" has been greatly amplified; and the descriptions of genera, species, and sub-species have been made much more elaborate, without loss, the author hopes, of that sharpness of definition which was the aim of the first edition and still having prominently in view the main purpose of the identification of specimens. The trinomial nomenclature, for the designation of sub-species and varieties—which "lends itself so readily" to the nicest discriminations of geographical races and the finest shades of variation—has been employed with much advantage, but not without a caution by the author against a too free use of it. The references to authorities, which were numerous in the first edition, have been omitted, and their place filled with additional notes about the habits and nesting of the species. The present edition contains about four times as much matter as the former one, and more than double the number of illustrations. We are sorry to observe that the author has not, in his preliminary chapters, preserved the dignity of style that is becoming in scientific works, or in any serious work, but has allowed himself to indulge too often in sensational expressions and jokes that are not always new or refined, to the unnecessary expansion of the text, without adding to its lucidity or its interest. The fault is not so obvious in the descriptive part of the book.

Mental Evolution in Animals. By George John Romanes, F. R. S., author of "Animal Intelligence." With a Posthumous Essay on "Instinct," by Charles Darwin. New York: D. Appleton & Co. Pp. 411. Price, $2.

In these systematic studies into the science of mind to which Mr. Romanes has recently appeared as an original contributor, the course of research breaks into three divisions. In the first, "Animal Intelligence," which appeared in the "International Scientific Series," the author devoted himself to the general data of his subject, or to the statement of the basal facts of comparative psychology. The book is chiefly descriptive of mental phenomena as observed in the lower animals, and aims at greater strictness than has hitherto been attained in determining what is trustworthy and what is doubtful among the alleged statements of fact in regard to mental manifestations among the lower creatures. As the volume was, however, a preparation for the study of psychological theories, its facts were chosen with reference to their bearing upon psychological principles to be subsequently investigated; the law of evolution was accepted as the guiding principle of the investigation, but the elaboration of the theory was postponed to a separate work. It was Mr. Romanes's intention to devote his second volume to the general discussion of evolutionary doctrine as displayed in mental phenomena of all orders; but, as he proceeded with the inquiry, materials accumulated, and the subject expanded to such proportions that it became necessary to divide the second part into two treatises—the one devoted to the evolution of mind in the lower animals, and the other to the evolution of mind in man. The volume now before us, the second published, is an exposition of comparative psychology on the basis of his first volume, and designed to exhibit mental evolution in the lower grades of the animal kingdom. The psychology of man is therefore expressly excluded from the volume before us, and the author offers, as one reason for this exclusion, that human psychology raises a class of questions with which he has no concern in dealing with comparative psychology. Prominent among these he assumes is the fundamental question whether, indeed, the principle of evolution is to be applied to the psychology of man. Although unqualifiedly assumed in his first volume and in the present as fundamentally true, and the sole key of interpretation in the lower sphere of mind, yet the author hesitates in its application to human psychology because Mr. Wallace differs with Mr. Darwin upon this subject. The issue between these great naturalists is, however, to be met and fully considered in the final volume.

Mr. Romanes explains in his introduction that, in treating of "Mental Evolution in Animals," he dismisses a class of inquiries hitherto involved in psychology, but which pertain rather to the philosophy than to the science of the subject. He deals with the science of psychology as distinguished from any theory of knowledge, limiting himself to the study of mind as an object, and of mental modifications simply as phenomena.

We can only briefly indicate the course of inquiry in the volume before us. Beginning with a search in the first chapter for "The Criterion of Mind," he then passes on in successive chapters to "The Structure and Functions of Nerve-Tissue," "The Physical Basis of Mind," "The Root Principles of Mind," "Consciousness," "Sensation," "Pleasures and Pains," "Perception," "Imagination," "Instinct," and this latter subject, which is the most prominent in the discussion, runs on from chapter eleventh to chapter eighteenth. "Reason" and "Animal Emotions" then come in for some consideration, and the volume closes with an appendix of thirty pages, consisting of a posthumous essay on "Instinct," by Mr. Charles Darwin, which was written for his book on "Natural Selection," but not included in it. Mr. Darwin left his psychological manuscripts to Mr. Romanes, to be printed or not as he thought fit, and he has included the essay on "Instinct" in his present disquisition on "Mental Evolution in Animals." It has been objected that Mr. Darwin was no psychologist; that he wrote on the subject long ago, and did not himself see fit to print what he had written; and that, on the whole, it would have been better for Mr. Darwin's reputation, and just as well for the world, if this old essay had not now been issued. But we think that Mr. Romanes was right in printing it. It can not seriously injure Mr. Darwin's reputation; and, if it does not help other people much, it will undoubtedly have interest as a record of the state of Mr. Darwin's mind upon that subject. If not a contribution to "Mental Evolution in Animals," it may possibly help to interpret the mental evolution of man.

THE FRANCO-AMERICAN COOKERY-BOOK; or, How to live well and wisely Every Day in the Year: containing over Two Thousand Recipes. By FÉLIX J. DÉLIÉE, Caterer of the New York Club, ex-Chef of the Union and Manhattan Clubs. New York: G. P. Putnam's Sons. Pp. 620. Price, $4.

THIS considerable volume claims to fill a void in our culinary literature. It presents three hundred and sixty-five different dinner-bills of fare, one for each day in the year, made up with reference to the resources of the changing seasons, and, following each, concise instructions are given how to prepare the various dishes designated. Such a work can not fail to be of service, not only to private families, but to clubs, restaurants, and hotels, and it could hardly have a better passport to general use in this country than the name of the experienced *chef* which appears upon its title-page. Each bill of fare differs almost entirely from the others, while at the same time the selection is made with strict regard to the products of the season and the supplies afforded by markets in American cities. Each is calculated for eight persons, though the cook or housekeeper may increase or reduce it at will by observing the proportions with care.

It is claimed that every dish described

may be prepared by a cook of ordinary intelligence and even limited experience—probably a pretty large claim. Particular attention seems to have been given to the preparation of soups, fish, and *entrées*, the reason assigned being that these branches of culinary art are too generally neglected in English cookery-books. The staple of the volume is, of course, its recipes, of which there are over two thousand, the several recipes used for the preparation of each dinner following immediately the bill of fare. In the index at the end of the volume every recipe is named, together with the number of the bill of fare to which it belongs.

The use of such a work where cookery is carried on in a somewhat ambitious and systematic way, and with some reference to its artistic refinements, is obvious enough, but it might undoubtedly prove helpful where the culinary processes are comparatively plain and simple. Perhaps it would be invidious to rank any one defect in ordinary cookery as worse than another, where they are all sufficiently conspicuous; but one of its most common defects is its distressing monotony, a few dishes being repeated over and over, with hardly an attempt at variation, while "canned products" enable the housekeeper to be exempt from the resources of the seasons, and to maintain the dreary monotony of dishes all the year round. Much of this is due to indifference and carelessness on the part of those who have kitchen operations in charge, and there are often dolorous complaints of the narrowness and poverty of the *cuisine*, when the real difficulty is that the manager will not give sufficient thought to it. Such a cyclopædia of culinary variations as the present ought certainly to give relief in this respect, and, if it can not be fully carried out, it offers abundant suggestions from which a varied and attractive dietary can be realized.

A Contribution to the Geology of the Lead and Zinc Mining District of Cherokee County, Kansas. By Erasmus Haworth. Oskaloosa, Iowa. Pp. 47.

A careful special study of a particular ore-bearing district of limited extent, prepared as a thesis in connection with an application for the degree of Master of Science from the Kansas State University.

Report on the Cotton Production of the State of Georgia. By R. H. Loughridge, Ph. D., of Berkeley, California. Pp. 184, with Maps.

With the special report Dr. Loughridge gives a description of the general agricultural features of the State. He has been assisted in both parts of the work by A. R. McCutchen, for Northwest Georgia. Georgia ranks first among the States in the acreage (2,617,138) devoted to the cotton-crop, and second—standing next after Mississippi—in the number of bales produced. Cotton is the chief crop of the State, and occupies thirty-four per cent of the land under cultivation, and 44·4 acres per square mile of all the land of the State. The average yield is one third of a bale per acre. The cost of production, exclusive of commissions, freights, etc., is about eight cents a pound. The subject of an "intensive" system of culture has lately attracted much notice, and some enormous yields have been realized. The report is full of information bearing upon every agricultural aspect of the State and of its several counties.

Whirlwinds, Cyclones, and Tornadoes. By William Morris Davis. Boston: Lee & Shepard. Pp. 90. Price, 50 cents.

This is a condensed meteorological study proposing a theory of storms, which formed the basis of a course of lectures by the author at the Lowell Institute in Boston in 1883. It was first published in several numbers of "Science," and is now reprinted with slight alterations in more convenient form. It will be a welcome addition to our slender resources in this field of scientific literature.

Massachusetts State Agricultural Experiment Station. Bulletins Nos. 7, 8, and 9. Pp. 12 each.

Bulletin No. 7, March, 1884, contains "Observations in regard to Insects injurious to the Apple," and "Experiments with Special Fertilizers in Fruit-Culture"; No. 8, April, "Fodder and Fodder Analyses, and "Valuation" and "Analyses" of Fertilizers; No. 9, May, "Notes upon Insects injurious to Farm and Garden Crops," and "Analyses of Fodder and Fertilizers."

Synopsis of the Fishes of North America. By David S. Jordan and Charles H. Gilbert. Washington: Government Printing-Office. Pp. 1,018.

The "Synopsis" is published as Bulletin No. 16 of the United States National Museum. In it the authors have endeavored to give concise descriptions of all the species of fishes known to inhabit the waters of North America, north of the boundary between the United States and Mexico. The classification adopted is essentially based on the views of Professors Gill and Cope. The rules of nomenclature generally recognized by naturalists, and recently formulated by Mr. W. H. Dall, have been followed, almost without deviation. Under the head of each species enough synonomy has been given to connect this work with other descriptive works, and no more; and the principal references are to the original descriptions of such species, to Dr. Günther's "British Museum Catalogue," and to other works in which special information is given, or some variant specific name is employed.

Home Science, Vol. I, No. 1, May, 1884. New York: Selden R. Hopkins. Pp. 112. Price, $2.50 a year.

A monthly magazine, the general scope of which is indicated by the title. The present number contains a variety of literary, popular scientific, and hygienic articles by popular authors, a "Health and Habit" department by Dio Lewis, and departments of a "domestic" character. The magazine is well printed, on good paper, and looks well.

Report to the Secretary of the Navy on Recent Improvements in Astronomical Instruments. By Simon Newcomb, Washington: Government Printing-Office. Pp. 27.

Professor Newcomb visited the principal observatories in Europe in 1883, for the purpose of taking note of the improvements in astronomical instruments which had been adopted in them, and this report embodies the results of his observations. Among the objects he describes are the great Vienna telescope and its mountings; the great domes at Paris and Vienna; the great Russian telescope at Pultowa, with the apparatus for mounting it, now making at Hamburg; reflecting telescopes in France, the equatorial *coudé* (a contrivance by the aid of which the eye-piece may always point to the north), the Strasburg meridian circle, etc. The observations are supplemented by the author's own practical conclusions.

American Meteorological Journal, Vol. I, No. 1, May, 1884. Professor M. W. Harrington, Editor. Detroit, Michigan: W. H. Burr & Co. Pp. 39. Price, $3 a year.

This journal is designed to be a monthly review of meteorology and allied branches of study. It takes up the subject earnestly and in a manner showing that the editor has a proper comprehension of what such a publication should be.

PUBLICATIONS RECEIVED.

United States Bureau of Statistics. Quarterly Report on Imports, Exports, Immigration, and Navigation, January to March, 1881. Washington: Government Printing-Office. Pp. 88.

Question-Book of Stimulants and Narcotics. By C. W. Bardeen. Syracuse, N. Y.: C. W. Bardeen. Pp. 40. 10 cents.

Knickerbocker Ready Reference Guide to 1,000 Points around New York. New York: National Railway Publication Company. Pp. 248. 25 cents.

On Induction in Telephone Lines, and Methods for its Prevention. By Edward Blake. Sheffield Scientific School, New Haven, Conn. Pp. 8.

South Side Views. By Rev. W. J. Scott. Atlanta, Ga.: James P. Harrison & Co. Pp. 80. 50 cents.

Scientific and Poetical Works of the Last of the Hereditary Bards and Skalds. Chicago: J. M. W. Jones Company. Pp. 95.

A Judicial Revolution. By Rodmond Gibbons. New York. Pp. 8.

"Paleontological Bulletin." No. 38. By Professor E. D. Cope. Pp. 88.

Civil-Service Reform. By Elial F. Hall. Temple Court, New York City. Pp. 12.

The Tertiary Marsupialia. By E. D. Cope. Philadelphia. Pp. 12.

Limits of Knowledge and Grounds of Belief. Anon. Pp. 20.

Institutional Beginnings in a Western State. By Jesse Macy. Baltimore: N. Murray. Pp. 38.

The Philosophy of Social Economy. By Stewart Bruce Terry. Glendale, Mo. Pp. 20.

Abnormal Human Skulls from Stone Graves in Tennessee. By F. W. Putnam. Cambridge, Mass. Pp. 3.

Catalogue of the Albany Medical College, Albany, N. Y. Pp. 20.

A New Stand (Chick's) for Skulls. By F. W. Putnam. Cambridge, Mass.

The Creodonta. By E. D. Cope. Pp. 30.

The Mastodons of North America. By E. D. Cope. Pp. 3.

Reasons for believing in the Contagiousness of Phthisis. By W. H. Webb, M. D. Philadelphia. Pp. 16.

American School of Classical Studies at Athens. Report of Director, 1882–'83. Washington: Government Printing-Office. Pp. 13.

Circular of Bureau of Education on Shorthand. Washington: Government Printing-Office. Pp. 159, with Plates.

Illiteracy in the United States, by Charles Warren, M. D.; and National Aid to Education, by J. L. M. Curry, LL. D. U. S. Bureau of Education. Pp. 99.

Mississippi State Board of Health. Biennial Report, 1882–'83. Jackson, Miss. Pp. 204.

Hillocks of Angular Gravel and Disturbed Stratification. By T. C. Chamberlain. Pp. 14.

Report on the Cotton Production of the State of Florida. By Eugene Allen Smith, Ph. D. Tuscaloosa, Ala. Pp. 77, with Maps.

Report on the Cotton Production of the State of Alabama. By Eugene Allen Smith, Ph. D. Tuscaloosa. Pp. 168, with Maps.

Diccionario Tecnológico (Technological Dictionary). Spanish and English. No. 7. New York: Nestor Ponce de Leon. Pp. 48. 50 cents.

Temperature of the Atmosphere and Earth's Surface. By Professor William Ferrel. Washington: Government Printing-Office. Pp. 69.

Notes on the Opium Habit. By Asa P. Meylert, M. D. New York: G. P. Putnam's Sons. Pp. 87. 40 cents.

The University: What it should do and be. By S. M. Clark. University of Iowa, Iowa City. Pp. 16.

The Science of Justice, etc. By Lysander Spooner. Boston: Cuppies, Upham & Co. Pp. 22.

The Revelations of Fibrin. By Rollin R. Gregg, M. D. Buffalo, N. Y. Pp. 7.

Theories of Color-Perception. By Swan M. Burnett, M. D. Washington, D. C. Pp. 25.

Première Application à Paris de l'Assainissement suivant le Système Waring (First Application in Paris of Waring's System of Sanitation). By Ernest Pontzen. Paris. Pp. 22, with Plates.

Geological and Natural History Survey of Minnesota, 1882. By N. H. Winchell. Minneapolis. Pp. 220, with Maps.

University of Minnesota. Calendar for 1883–'84. Pp. 128.

Contributions to the Flora of Cincinnati. By Joseph F. James. Pp. 14.

The Minnesota Valley in the Ice Age. Pp. 16; Changes in the Currents of the Ice of the Last Glacial Epoch in Eastern Minnesota. Pp. 4. By Warren Upham. Salem Press, Salem, Mass.

Neglect of Bodily Development of American Youth. By A. Reinhard. Syracuse, N. Y.: C. W. Bardeen. Pp. 16.

The Bearing of certain Determinations on the Correlation of Eastern and Western Terminal Moraines. By Professor T. C. Chamberlain. Pp. 5.

Property in Land. A Passage-at-Arms between the Duke of Argyll and Henry George. New York: Funk & Wagnalls. Pp. 77. 15 cents.

To Mexico by Palace-Car. By James W. Steele. Chicago: Jansen, McClurg & Co. Pp. 96. 25 cents.

White Elephant Chimes. Selected by P. T. Barnum. Buffalo, N. Y.: Courier Office. Pp. 51.

"Catholic"; An Essential and Exclusive Attribute of the True Church. By Right Rev. Monsignor Capel, D. D. New York: Wilcox & O'Donnel Company, and D. & J. Sadlier. Pp. 140. 50 cents.

Modern Reproductive Graphic Processes. By James S. Pettit. New York: D. Van Nostrand. Pp. 127. 50 cents.

Recent Progress in Dynamo-Electric Machines. By Professor Sylvanus P. Thompson. New York: D. Van Nostrand. Pp. 113. 50 cents.

Stadia Surveying. By Arthur Winslow. New York: D. Van Nostrand. Pp. 148. 50 cents.

Lessons in Chemistry. By William H. Greene, M. D. Philadelphia: J. B. Lippincott & Co. Pp. 357. $1.25.

South Carolina: Resources and Population; Institutions and Industries. Published by the State Board of Agriculture. Columbia. Pp. 726.

Systematic Mineral Record. By Edward M. Shepard. New York and Chicago: A. S. Barnes & Co. Pp. 26.

The Principles of Ventilation and Heating. By John S. Billings, LL. D. New York: "The Sanitary Engineer." Pp. 216. $3.

Commentaries on Law. By Francis Wharton, LL. D. Philadelphia: Kay & Brother. Pp. 856.

The Book of Plant Descriptions and Record of Plant Analysis. By George C. Groff, M. D. Lewisburg, Pa.: Science and Health Publishing Company. Pp. 100. 30 cents.

Forestry in Norway. By John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 227.

POPULAR MISCELLANY.

Instruction of the Deaf.—Mr. Alexander Graham Bell addressed the Philosophical Society of Washington at one of its recent meetings on the subject of "Fallacies concerning the Deaf, and the Influence of those Fallacies in preventing the Amelioration of their Condition." He condemned the common phrases "deaf and dumb" and "deaf-mutes," as expressing what is not true; showing that those whom we term "deaf-mutes" have no other natural defect than that of hearing, and that they are dumb not on account of lack of hearing, but of lack of instruction. No one teaches them to speak. The gesture-language which such a child may use is developed by him at home, not because it is the only form of language natural to one in his condition, but because his parents and friends neglect to use the English language in his presence in a clearly visible form. The sign-language of our institutions is objected to as an artificial and conventional language, so far from being natural that it is not understood by deaf children on their entrance to an institution, and hearing persons can not be qualified to teach it till after many years. Practice in it hinders the acquisition of the English language; makes the deaf associate together in adult life, and avoid the society of hearing people; and thus causes the intermarriage of the deaf and the propagation of their physical defect. Dr. Bell holds that written English can be taught to deaf children so as to become their vernacular, and that, when they have been made familiar with it in either its written or spoken form, they can be taught to understand the utterances of their friends by watching the mouth. The requisites to the art of speech-reading are, an eye trained to distinguish quickly those movements of the vocal organs that are visible (independently of the meaning of the words uttered); a knowledge of these words that present the same appearance to the eye; and sufficient familiarity with the English language to enable the speech-reader to judge by context which word of a homophenous group (like-seeming) is the word intended by the speaker. We should, therefore, teach deaf children to think in English, by using English in their presence in a clearly visible form; teach them to speak, by giving them instruction in the use of their vocal organs; teach them the use of the eye as a substitute for the ear in understanding the utterances of their friends; give them instruction in the ordinary branches of education by means of the English language; and banish the sign-language from our schools.

Bogus American Antiques.—According to the sixteenth report of the Peabody Museum, the manufacture of false American antiquities is becoming an industry of our country. The museum has been offered an "ancient" child carved from stone, duly incrusted with cement, said to have been dug up in Arkansas, the workmanship of which, and the presence of undecayed grass-leaves and yellow printing-paper in the incrustation, showed it to be a near relative of the Cardiff giant. This, however, is only one of many fraudulent specimens that are on sale. Pipes, tubes, dishes, and ceremonial and other objects, are regularly manufactured in Philadelphia, and have found their way into American and foreign collections as genuine antiquities, dug up in such or such a locality. A manufacturer in Indiana gives his attention chiefly to "mound-builders' pipes," which are carved in stone and offered in a systematic manner to collectors. In Ohio a large business has been done in the so-called gorgets, cut from slate, and in hematite celts. In Southern Illinois, a few years ago, specimens of pottery were made till the demand fell off, so that one manufacturer acknowledged that the business no longer paid. On the whole, says Professor Putnam, "the demand for 'antiquities' is considerable in this country, and we are not behind the Old World in keeping up the supply."

The Nettle as an Economical Plant.—The nettle, which is now only rarely cultivated, was held in high honor as a useful plant not more than two hundred years ago. In a medical treatise of the fifteenth century, several pages are occupied with the description of its healing properties. It is said to have been turned to account for food during the Irish famine. In Russia, Sweden, and Holland, it is mowed and made into fodder for cows, with profit in the increase in quantity and improvement in quality of the milk, although the animals will not venture to eat it while it is green. Cords are made from it in Kamchatka, paper in France, and grass-cloth in China and India. It has been made into linen in various countries, a fact of which the German name for muslin, *Nesseltuch* (nettle-cloth), is a standing testimony. When cotton came into general use for textile fabrics the nettle went out, and was nearly forgotten till attention was called to it anew by Professor Reuleaux after our Centennial Exhibition. Frau Rössler-Lade took the matter up and showed how easily the plant could be cultivated and how well adapted it was to spinning. Numerous persons have since engaged in the cultivation of the native species, and of the Chinese nettle, which is considered a little superior, in Germany and other countries. A company has been formed in Holland for the cultivation of the nettle in Java, with a capital of about three million guilders.

Correlations of the Seasons.—The universal mildness of the past winter in Northern Europe has caused attention to be directed to the inquiry whether there is a correlation in character between that and other seasons of the year. Mild winters are by no means rare in that quarter of the world: several may be cited in the last half-century, particularly that of 1842–'43, when the fields around St. Petersburg were bright with flowers in December and violets gathered in the woods were sold in Stockholm in January. Herr G. Hellman has made a special study of the mild winters in Berlin since 1720. He counts thirty-four seasons since 1755 when December and January were warmer than the mean. The warm seasons come at irregular intervals, and do not suggest any law; seventeen of them came between 1755 and 1821, and seventeen between 1821 and 1884. In seventy-six per cent of these exceptional winters, the month of November also was warmer than usual. Herr Hellman asserts that the chances are eighty-one to nineteen that a warm February will follow a warm December and January, and fifty-seven to forty-three that the same will be the case with March. Thus, the chance is that a winter that begins by putting on a mild face in November will preserve the same aspect all through. In regard to the seasons following these exceptional winters, Herr Hellman finds that a moderately mild winter is more frequently followed by a cold spring, and a very warm winter more usually by a warm spring; and, in general, that the warmer the winter the warmer will be the ensuing spring. These conclusions contradict popular notions.

Physiographic Conditions of Minnesota.—In a lecture on the "Physiographic Conditions of Minnesota Agriculture," recently delivered before the State Horticultural Society, Professor C. W. Hall claimed for that State a nearly central position on the North American Continent, as fixed by lines drawn from Eastport to Astoria, and from Behring Strait to the Isthmus of Panama. Of its area, 83,365 square miles, 78,600 square miles are land, while the rest of the territory is occupied by some 8,000 or 10,000 lakes; 48,000 square miles are forest, and 31,000 prairie. Not quite 40,000 square miles are drained into Hudson Bay, and 7,689 square miles into the St. Lawrence, while the rest of the area of the State sheds its water into the Mississippi. The height of the land ranges from 602 feet above the sea, at Lake Superior, to 2,400 feet in the highest part of the Mesabi, or dividing range between the water-sheds, and averages, for the whole State, perhaps about 1,200 feet. Much of Minnesota is covered by the drift, the various constituents of which—granites and schists, sandstones, clays, and limestones—have been ground up and mingled in utter confusion, so that the land is adapted to the greatest diversity of crops. The average annual rainfall is about 28·27 inches, or about three quarters of an inch less than the average for the whole United States, excluding Alaska. The average January temperature is nearly 12° Fahr., while the July average is nearly 71° Fahr; and the difference between the warmest summer day and the coldest winter night is about 120° Fahr. A reduction in the average temperature is observed of one degree for every 350 feet of additional elevation. As in Nebraska, a gradual increase in rainfall appears to be taking place as more of the prairie-soil is brought under the plow; and the streams are becoming larger, and springs are flowing where once water could not be obtained.

An Absolute Unit of Light.—An absolute standard for the measurement of the intensity of light has long been wanting. All the standards heretofore proposed are imperfect, because in none of them has it been possible to secure complete uniformity in intensity and color. A satisfactory standard should be identical at all times and in all places; should be of convenient size; and should be white enough to be comparable with all modern lights in every region of the spectrum. These conditions appear to be fulfilled in the standard proposed by M. Violle in 1881, which, after some improvement in processes, has been definitely adopted by the International Congress of Electricians. It is the light emitted by a square centimetre of melted platinum at the temperature of solidification (1,775° C., or 3,227° Fahr.). This light nearly resembles the incandescent electric light, and is constant during the whole process of solidification. Its value, expressed in one of the old standards, is 1 carcel = $\frac{1}{2\cdot08}$ of the Violle unit.

Birds' Tastes for Color and Music.—Mr. E. E. Fish has published in the "Bulletin" of the Buffalo Naturalists' Field-Club a paper on "The Intelligence of Birds," in which he ascribes to birds a keen perception of color and capacity to be gratified by artistic arrangements of colors, and a strong susceptibility to musical melodies. Evidence of the enjoyment of color is given by the tasteful combinations with which many birds adorn their nests, and by instances in which their choice of companions, food-fruits, etc., is guided by color. Many of the feathered tribes also "manifest real pleasure at the execution of simple harmonies. They enjoy the notes of musical instruments, but more especially their own songs and those of one another. . . . Our unmusical English sparrow enjoys the songs of other birds; on different occasions I have seen several of them gather about a robin as he caroled a pleasant song; when they came too near or in too large numbers, he would dart at them and drive them out of the tree, but when he commenced again to sing some of them were quite sure to return. A friend sends me an account of a bobolink, that placed in a cage with some canaries exhibited great delight at their songs. He did not sing himself, but with a peculiar cluck could always set the canaries singing. After a while he began to learn their songs, note by note, and in the course of a few weeks mastered the entire song." The goose is also fond of music, "and a lively air on a violin will sometimes set a whole flock wild with delight. On one occasion, at a country wedding, I was witness of a curious performance by one of these animals. After dinner a lady entertained the guests assembled on the lawn with music from an accordeon. A flock of geese were feeding in the road just below the house, and with outstretched necks answered back loud notes of satisfaction. Soon a white gander commenced dancing a lively jig, keeping good time to the music. For several minutes he kept up the performance, to the great delight of the company. The experiment was tried several times for a week or more, and the tones of the accordeon never failed to set the old gander into a lively dance."

Milne-Edwards's Marine Investigations.—M. Alphonse Milne-Edwards has expressed himself well satisfied with the results of his deep-sea expedition in the Talisman. He claims to have corrected some of the soundings as given in a recent German atlas, and to have traced a different relief from the one indicated in it for the ocean-bed. He found the bottom of the Sargasso Sea—six thousand metres deep—to be of a volcanic character. Some of the lavas and scoriæ in the collection the expedition has brought home seem to be of relatively recent origin, and to offer an explanation of the poverty of the flora of the region in which they were found. In a letter to the French Geographical Society, M. Milne-Edwards speaks of an immense volcanic bed running parallel with the Andes, of which the Cape Verd Islands, the Canaries, and the Azores form the culminating peaks, and which, he conjectures, may extend to Iceland.

The Glacial Dam and Lake of the Ohio River.—Professor G. Frederick Wright, in tracing the boundary-line of the glaciated area through Ohio, found that it crossed over into Kentucky in the neighborhood of Cincinnati, returning, however, to the north side of the Ohio River at a few miles farther down. Examining the ground more closely, he found that the entire valley of the river, for a distance of fifty miles in this region, had been, for a short time during the glacial period, filled with glacial matter which formed a dam at least five hundred and fifty feet high. The effect of this must necessarily have been to make a narrow lake corresponding in depth with the ice-barrier, and extending far up the Ohio and its tributaries, including the Licking in Kentucky, the Kanawha in West Virginia, and the Alleghany and Monongahela in Pennsylvania, and covering the present site of Pittsburg to a depth of about three hundred feet. Evidence of the former existence of such a lake, in the shape of terraces marking its margin, has been found along these rivers, in one case independently of Professor Wright's investigations. Professor J. C. White, of Morgantown, West Virginia, and of the Pennsylvania Geological Survey, says that it is exactly what is needed to explain the terraces along the Monongahela, which extend from Pittsburg as far south at least as Fairmount, West Virginia, one hundred and thirty miles, and "suddenly disappear at an elevation of one thousand and fifty or one thousand and seventy-five feet above tide, or about two hundred and seventy-five feet above the river." Professor Lesley has observed terraces along the Alleghany and its tributaries, at the same absolute level. Along the Great Kanawha, water-worn bowlder deposits disappear at an elevation of from two hundred to three hundred feet above the present level of the stream. A deserted river-channel, now followed by the Chesapeake and Ohio Railroad, and more than two hundred feet higher than the present river, extends from fifteen miles below Charleston to Huntington, at the mouth of the Guyandotte, through which the Kanawha once flowed to the Ohio. A similar deserted channel, of a similar height, extends from near the mouth of the Big Sandy to Greenupsburg, Kentucky. Mr. G. H. Squier reports evidences of a terrace on the Licking River, near Owingsville, Bath County, Kentucky; and the fact had so impressed him that, before knowing of Professor Wright's discoveries, he had come to the conclusion that some such barrier as is supposed must have existed.

Value of Brain-Weighings.—Recent statements about the weight of Turgenief's brain, which was extraordinarily heavy, have provoked questions as to the value of such data. Mr. Nikiforoff has published an article on the subject. The suggestion is raised that the significance of the weight of the brain is not absolute, but should depend upon the proportion the brain bears to the dimensions of the whole body, and to the weight of the individual. Byron died at the age of thirty-six, and the great geometrician Gauss at seventy-eight years of age. The brains of the two should, therefore not be compared. It is equally important to know what was the cause of death, for protracted disease and old age exhaust the brain. To define the real degree of development of the brain, it is, therefore, necessary to have a knowledge of the condition of the whole body, and, as this is usually lacking, the mere record of weights possesses little significance.

The Boring Power of Mollusks.—Professor F. H. Storer suggests, in a note to Professor Dana, that the shell and rock-boring mollusks owe their excavating power in large part to chemical actions which they induce. Having observed how readily saline compounds are decomposed by way of osmose when put in contact with moistened membranes, and particularly with living membranes, like those in the rootlets of plants, and how plant-roots actually decompose mineral substances, he conceives it probable that mollusks also do their boring by means of chlorhydric acid formed through the decomposition of sea-salt by certain of their tissues. The boring has usually been regarded as a kind of drilling performed by the tooth-like processes attached to the proboscis of the mollusk. Professor Storer does not deny that the teeth may aid in the process of removing the softened shell, but believes that an acid solvent acting upon the shell is primarily operative; and he proposes the question as a fit subject of experimentation.

Sir Bartle Frere.—Sir Henry Bartle Edward Frere, Bart., a distinguished officer in the English colonial service, and a promoter of geographical exploration, died at his home in Wimbledon, England, on the 29th of May. He was born in 1815, and spent his earlier years in the Indian civil service, where he became Governor of Bombay, and member of the Council of India. In 1872 he was deputed on a special mission, connected with the suppression of the slave-trade, to Zanzibar, where he was able to render efficient aid to African exploration. His interest in this work began in 1865, when he helped to raise means to start Livingstone on his last expedition, and gave him an official letter to the Sultan of Zanzibar. At Zanzibar, in 1872, he superintended the departure of Cameron's expedition for the relief of Livingstone. He was an active member of the Royal Geographical Society from 1867, and furnished many papers to it, and was President of the Geographical Section of the British Association in 1869. In 1877 he was appointed Governor of the Cape of Good Hope, and High Commissioner for South Africa. He was prominent in the transactions that led to the war with the Zooloos. He was, says Sir Richard Temple, "a born geographer."

The Fleuss Breathing Apparatus and Safety-Lamp.—The Fleuss apparatus for breathing under water and in irrespirable gases, which was described in Vol. XVI, page 717 (March, 1880), of "The Popular Science Monthly," has acquired a considerable use and has proved efficient in practice. Mr. Fleuss has also, in conjunction with Mr. Foster, produced a safety mining-lamp which depends for its vitality on principles similar to those of the breathing apparatus, and is equally useful and safe under water and in the most dangerous gases. It is essentially a lime-light, ignited by the burning of methylated spirits instead of hydrogen gas, and securely guarded against contact wlth the outer air. It will burn for four hours equally well under water, in carbonic acid, or in fire-damp, and it can not get hotter than boiling water. Its usefulness, says "Iron," "we have seen demonstrated by a diver at the Fisheries Exhibition, who, equipped with the breathing apparatus, and having a Fleuss lamp, remained for long periods under water, both man and lamp being wholly cut off from the outer atmosphere during the periods of immersion. In like manner we have seen the respiratory apparatus put to the test by a man equipped with it remaining for some time in an air-tight iron chamber filled with dense smoke and noxious vapors. But above and beyond this is the experience which has been gained from its use in actual practice, notably in the case of the flooding of the Severn Tunnel, as regards subaqueous work, and in the cases of the Seaham and Killingworth collieries with respect to coal-mine accidents." In the case of the explosion at the Lycet collieries, in which several lives were lost, an early exploration, which in ordinary circumstances would have been impossible, was safely effected by means of the Fleuss apparatus.

The Army-Worm.—Several caterpillars have been popularly but inaccurately called the army-worm; but, according to the recently published pamphlet by Professor Riley on the subject, the real worm which is so destructive to growing grass and grain is the *Leucania unipunctata*, a species that has a very wide range on this continent. The worm is the larva of a moth about an inch and a half in wing-expansion, and of a reddish-gray color, which lays its eggs in wild or cultivated grass, or in grain, along the inner base of the terminal blades, where they are yet doubled, or between the stalk and its surrounding sheath, or even in the cut straw of old stacks, or in corn-stalks. The larvæ feed for a time after hatching in the fold of the leaf, which they so resemble in color as usually to escape observation. They are stationary in habit so long as they have sufficient feed, but take up the march when their pasture is exhausted; and in those seasons when they have been multiplied to excess they constitute a veritable army marching in solid rank. Their occasional sudden appearance in vast numbers over large stretches of territory is one of the phenomenal features of their life; but it is not so wonderful a fact, after all. They are nearly always with us in greater or less numbers, and if the season is a dry one they multiply prodigiously. An immense crop of moths is accordingly produced, and then, each one of them laying seven or eight hundred eggs, stock the fields and pastures in profusion, depositing the eggs for the immense host which is to appear in the following year. In confirmation of this view, examinations of the weather records show that the years preceding army-worm years have been universally characterized by drought. Three broods of them may be produced in a year. Their natural enemies are not less than fourteen species of birds, a metapodious bug, and numerous parasites. The usually applied remedies look to the wholesale destruction of the worms or the eggs. Among them are burning the old grass, preferably as late as possible in the spring; digging a ditch to serve as a trap into which they will fall on their march, after which they may be destroyed in various ways—mashing them in the field with heavy rollers, and dragging a rope across the field to crush them. Thin tillage is also a preventive, by causing the worms to be exposed to the sun.

What destroyed Casamicciola?—Professor Palmieri, of the Mount Vesuvius Observatory, believes that the destruction of Casamicciola, in Ischia, was not the immediate effect of the earthquake, but was caused by a caving in of the ground under the city, which might, perhaps, have been precipitated by an earthquake-shock. The trachytic rocks on which the town is built rest upon a bed of clay, in which extensive galleries have been dug in the course of centuries, while the clay has been mined for industrial purposes. As early as 1837, an engineer, Alessandro Giordano, called attention to the danger of extending these excavations farther toward the city. Add to this the action of the carbonic waters of the thermal springs in hollowing out caverns in the trachytic rocks, and we have probable a condition of the subsoil and underlying formations extremely perilous to the stability of the foundations of the town, and one under which just such a disaster as has overtaken it might be readily conceivable.

M. Wroblewski has been investigating the boiling-points of air, oxygen, nitrogen, and carbonic oxide, at the ordinary pressure of the atmosphere, and fixes them as follows: Oxygen, 299° Fahr.; atmospheric air, 314°; nitrogen, 315·5°; carbonic oxide, 314·4°. Atmospheric air seems destined to be the refrigerant of the future, for it is already at hand, and will produce a degree of cold that is only insignificantly exceeded by that induced by any other substance. It must, of course, be first compressed and liquefied; then, when it is to be used, it will be let loose to freeze by its evaporation, as is now done with other refrigerants operating in a similar way.

M. Gustave Hermite describes a method of taking phosphorescent photographs, which he has found to be practicable with any phosphorescent substance, but for which he prefers sulphuret of calcium, a material from which a luminous paint is made. This substance is very sensitive to light, and assumes a phosphorescence the intensity of which is proportioned to the intensity of the light to which it is exposed, rather than to the length of the exposure. A glass plate is painted with it, and is exposed in a bright light in the face of the object of which a picture is desired. The picture appears very distinct when the plate is taken into the dark. It may be revived afterward by breathing upon the plate, and then passing a hot flat-iron over it. Sulphuret of calcium becomes phosphorescent under the influence of heat (300° C.) as well as of light.

M. E. L. Trouvelot has concluded, from observations on the planet Saturn for several years, that his rings are not fixed but very variable; and that the hypothesis that they are composed of multitudes of corpuscles or minute satellites, revolving in independent orbits, is very probable, and affords the best explanation of the phenomena.

NOTES.

Dr. Austin Flint is quoted in the seventeenth report of the Peabody Museum as authority for the statement that the *metates*, or grinding-stones, used in Nicaragua, are obtained from the old burial-mounds. Dr. Flint informs us that this is true, so far as the northwestern departments of Costa Rica are concerned, but that the idea of the same being the case in Nicaragua is an error, arising from an inaccuracy of his own expression incidentally committed in writing hurriedly on another subject. The *metates* in universal use in Nicaragua are made there now, and are much inferior to those found in the mounds; and, being of much less value, they are gradually being bought in Costa Rica.

The biological class at the University of Cambridge has outgrown the capacity of any lecture-room to accommodate it, and at the last term numbered two hundred in the elementary department alone. A considerable number of graduates remain at the university engaged in biological research, and the museums are continually being enriched with specimens presented by recent graduates who are traveling on scientific expeditions.

General Sir Edward Sabine, for ten years President of the Royal Society, and for twenty years General Secretary of the British Association, recently died at Richmond, England, aged ninety-four years. After serving on the English side in the war which we call the War of 1812, he became officially engaged in scientific work, and served his government and the scientific associations for twenty years in astronomical and magnetic investigations, in the course of which he was connected with several Arctic and marine expeditions. He was elected General Secretary of the British Association in 1839, Foreign Secretary of the Royal Society in 1846, and Vice-President and Treasurer of the same in 1850; and was President of the Royal Society from 1861 to 1871. Our present conception of the exact figure of the earth is said to be mainly due to his investigations. A portrait and sketch of General Sabine were published in the second number of Vol. II of "The Popular Science Monthly."

M. Pasteur, in consideration of his researches in hydrophobia, has been awarded a gold medal by the French *Société Centrale pour l'Amélioration des Races des Chiens*.

The London Sanitary Protective Association, at the close of its second year, had five hundred and thirty-three members. During the year it had secured the inspection of three hundred and sixty-two houses, with the discovery and correction of many serious errors in sanitary arrangements. Six per cent of these houses had their drains choked up so that the foul water from the sinks simply soaked into the ground; in thirty-two per cent of them the soil-pipes were leaking, and sewer-gas could escape into the house; in thirty-seven per cent the overflow-pipes from cisterns passed direct into the drains or soil-pipes, admitting sewer-gas into the water of the cistern and into the house; and in three fourths of the houses waste-pipes from baths and sinks led direct into the drainor soil pipes instead of, as they should, direct into the open air. Professor Huxley resigned the presidency of this society, and was succeeded by the Duke of Argyll.

Mr. Harold Palmer, an English health inspector, has reported an infectious form of pneumonia in his district. A man was attacked with symptoms suggesting that septic poison and bad sanitary conditions might be around, and examination confirmed the opinion. Three other persons were seized with the disease, and two of the patients, including the medical attendant, died. Other similar cases have been observed, in one of which inflammation of the lungs and death followed a single visit to a house where the disease was prevailing.

Dr. A. J. C. Geerts, Professor of Natural Sciences, etc., in Japan, died recently at Yokohama, aged forty years. He was invited by the Japanese Government, in 1868, from a professorship at Utrecht, to fill a similar position in the new medical school at Nagasaki. He afterward became a member of the health department at Tokio, and established chemical laboratories at Kioto and Yokohama. He contributed to the two learned societies of Japan, published a Japanese pharmacopœia, and began a colossal work on the "Products of Nature in Japan and China."

Railroad-cars are indicated by Judge Lawrence Johnson, of Holly Springs, Mississippi, as vehicles by which destructive moths are carried from one part of the country to another. In traveling last year he was often struck by the numbers of *Aletiæ* on the trains; and he observes that there was a sort of coincidence last season between lines of railroad and abundance of cotton-worms.

Mr. W. A. Forbes, Prosector of the London Zoölogical Society, died on an expedition up the Niger, January 11th, of dysentery at less than thirty years of age. He was a well-known writer on zoölogical subjects. He contributed a memoir on the petrels to the reports of the Challenger Expedition, and edited the collected papers of Professor Garrod, his predecessor as prosector.

The Board of Trustees of Johns Hopkins University announce, as a special feature of the university course of instruction in physics for 1884–'85, a series of eighteen lectures, to be delivered by Sir William Thomson, in October, on "Molecular Dynamics." The programme also includes lectures by Professor Rowland, on "Electricity and Magnetism"; by Associate Professor Craig, on "Analytic Mechanics," "Hydrodynamics," and "Partial Differential Equations"; and by Dr. Franklin, on "Problems in Mechanics," with general lectures by Dr. Kimball.

Henry Watts, F. R. S., editor of the "Dictionary of Chemistry," died of syncope, from failure of the heart's action, June 30th, in the seventieth year of his age. He was graduated Bachelor of Arts in the University of London in 1841, and was Demonstrator of Anatomy in University College, London, under Professors Fownes and Williamson, from 1846 to 1857. He translated and supplemented Gmelin's "Handbook of Chemistry," composing a work of eighteen volumes. Having begun a new edition of Ure's "Dictionary of Chemistry and Mineralogy" in 1858, he soon found that, to bring it up with the times, the book would have to be rewritten. Calling in the aid of other students, he produced his great work in five volumes, in 1868. Three supplements were added to it, in 1872, 1875, and 1879–'81. He also brought out three editions of Fownes's "Manual of Chemistry," and had a fourth ready.

Alphonse Lavallée, a distinguished French student of trees, and writer upon them, died at his home in Segrez, on the 3d of May, in the fiftieth year of his age. His collection of trees and shrubs is the richest and most complete *arboretum* ever established. In preparing the catalogue of it some years ago, he introduced considerable reforms in nomenclature and synonymy, which he elaborated in the second edition of the work. Among his works was the "Arboretum Segrezianum," intended to furnish descriptions of the rarest plants of his collections, richly illustrated with steel-plate engravings, and an illustrated folio on large-flowered clematises. He was about to publish a similar work on *Cratægus*, or the thorn. He was President of the Central Horticultural Society of France.

M. E. Bergman has observed that formic and acetic acid occur in the protoplasm of all the plants he examined for them, being found in the colorless cells and in the green tissues; and he considers it probable that several other acids of the fatty series are equally diffused in the vegetable kingdom.

LORD RAYLEIGH.

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THE SIGNIFICANCE OF HUMAN ANOMALIES.

By FRANCIS J. SHEPHERD, M. D.

EVER since the study of human anatomy has attracted any attention, variations in the arrangement of the different structures of the body have been noticed. For many centuries, the signification of these variations was not understood; and even as lately as 1840, Dr. Knox, of Edinburgh, who had the courage to state his conviction that they connected man with the lower animals, was looked upon, even by members of his own profession, as one prompted by the evil-one. In early times, when great prejudice existed against the dissection of human bodies, and animals, such as monkeys, dogs, cats, etc., were frequently used as substitutes, the similarity of some of their muscles to those which occasionally occurred in man as anomalies, forced the anatomists to remark on them as being curious coincidences, though in their published works they drew no conclusions from their occurrence bearing on the origin of man.

In the view of our present knowledge of the animal kingdom and its development, and with the acceptance of the great principle of evolution, the explanation of these variations is simple enough, viz., that they point to the fact that man has descended from some lower form, and "is the co-descendant with other mammals of a common progenitor" (Darwin).

Again, many structures which in man are merely rudiments and quite useless, nay, sometimes a source of danger, are seen fully perfected in some of the lower animals, and in them fulfill a definite purpose. The existence of such rudimentary organs (or, as Haeckel calls them, "worthless primeval heirlooms") as the ear-muscles, the appendix vermiformis in the intestines, the thyroid gland, the remnant of the third eyelid, the rudimentary tail-bones, and many others, is not satisfactorily accounted for on the theory of the plan of general unity; but if we look upon them as parts which have become functionless and atrophied from want of use, and by heredity have been transmitted from generation to generation, a bright light is thrown on the reason of their existence. In the present paper I do not intend to dwell on the significance of rudimentary organs which exist normally in man, but shall confine myself to those structures which occur as variations.

I might here mention that some parts, as for instance certain muscles of the thumb, occur in man, but not in the lower animals; these we may take as indications of the advance of man to a still higher development.

To the study of embryology we owe much in elucidating many morphological problems, and removing others from the domain of theory. By our knowledge of this most intricate subject the significance of many variations and rudimentary organs is made plain.

It has been well said that "the development of the individual is the compressed development of the race in the process of compression; some features are suppressed or modified, and others are thrown into relief." In the development of the embryo we see the history of the race, but the higher the form the more quickly does the embryo pass through those stages and transformations which are the equivalent of what is persistent in types below. In lower forms these stages are much less rapid, and in fact are true metamorphoses. The changes occurring in the development of the common frog will furnish a familiar example of this latter statement. The more we know of embryology, the more the truth of the saying that "development means descent" is apparent.

It may not be generally known that no two individuals have exactly the same anatomical structure, and that nearly every one has in him some bony prominence, supernumerary muscle, or abnormal blood-vessel, which tells the tale of his descent. During the past nine years I have been teaching anatomy, and nearly three hundred subjects have been dissected under my immediate supervision; in these I have carefully noted the variations occurring, with the result of finding that scarcely one body is perfectly normal in every part—nay, many are very abnormal, having as many as thirty to forty variations in their bones, muscles, or arteries. I have found variations to occur more frequently in negro and Indian subjects than in those of European descent. When a variation in a bone, muscle, or blood-vessel is found, the first question asked is, What is its morphology? and it is the exception not to be able to make it out; if one fails, it is concluded that our knowledge is deficient, and that the variation has a history, if we could only discover it.

Many variations are explained when an appeal is made to comparative anatomy, a science which is as yet very incomplete, but which is rapidly enlarging its boundaries. Some animals we know by their fossil remains, and in these merely their bony structure can be studied; all the soft parts are, of course, lost forever, and can only be approximately restored by our knowledge of allied existing types of the same animals. With these few preliminary remarks I shall proceed to describe, as simply as possible, some anomalies I have myself met with, and the significance of which I shall endeavor to make clear.

Osseous System.—In a skull in my possession, whose lowness of type is manifested by the narrow forehead, prominent supraorbital ridges, wide arches of bone to inclose the large masticatory muscles, the acute facial angle, prognathous jaws, and well-marked bony prominences, are two remarkable variations:

1. *An Epihyal Bone.*—In all human beings there is near the ear-opening a bony spine, generally about half an inch long, and which is called, from its resemblance to an ancient pen, the styloid process; the lower end of this is connected with the hyoid or tongue bone of the neck by a fibrous cord. Now, in this skull, the styloid process is not connected with the little tongue-bone by a fibrous cord, but the

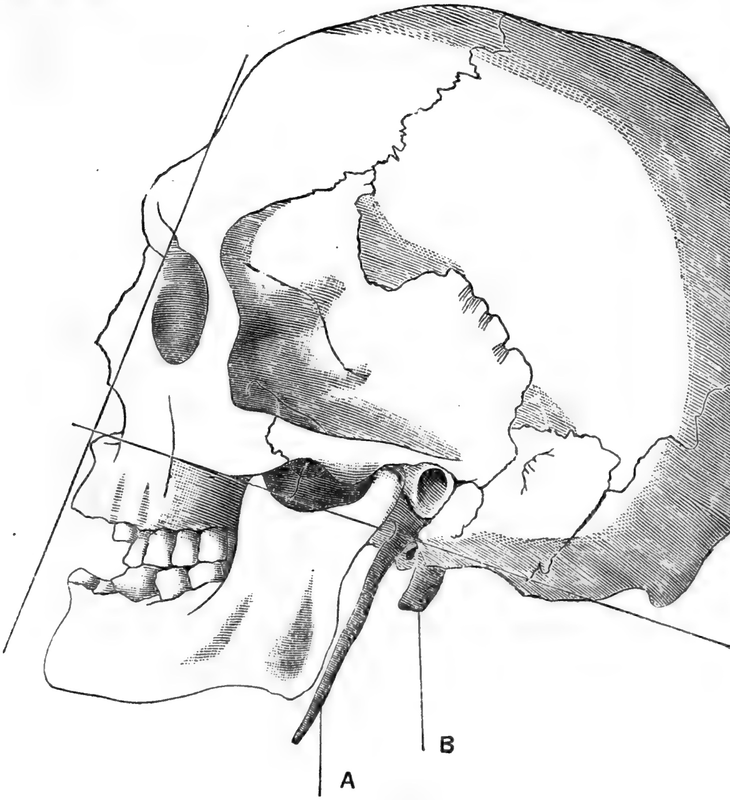

Fig. 1.

styloid process is itself prolonged down to the tongue-bone and articulated with it in the fresh state. It is quite a large bone, three and a half inches long (see Fig. 1, *A*). This arrangement is seen in many of the lower animals, and in them the bone, which is a very important one, is called the *epihyal bone.*

2. At the base of the skull on the left side, behind the mastoid process, the prominent nipple-shaped process behind the ear, is a stout, bony spur, more than three quarters of an inch long, which has a downward direction, and articulates with the first bone of the vertebral column (see Fig. 1, *B*). This process is rarely seen in the human being, and is the only one I have met with, but it is quite the normal condition in most graminivorous and carnivorous animals, being especially well marked in the horse, pig, sheep, and goat. In them it is an important part, and gives attachment to strong muscles which move the head on the trunk. It is called the para-mastoid process, from its proximity to the mastoid.

Supernumerary Ribs.—I suppose every one is aware that the vertebral column, or backbone, is composed of many separate bones, some of which carry ribs. The backbone is made up of thirty-three bones, seven in the neck, twelve in the trunk, five in the loins; below this we have a bone called the sacrum, which consists of five vertebræ fused together; and lower down still four small bones which represent the tail-bones, called, when taken together, the coccyx, from their

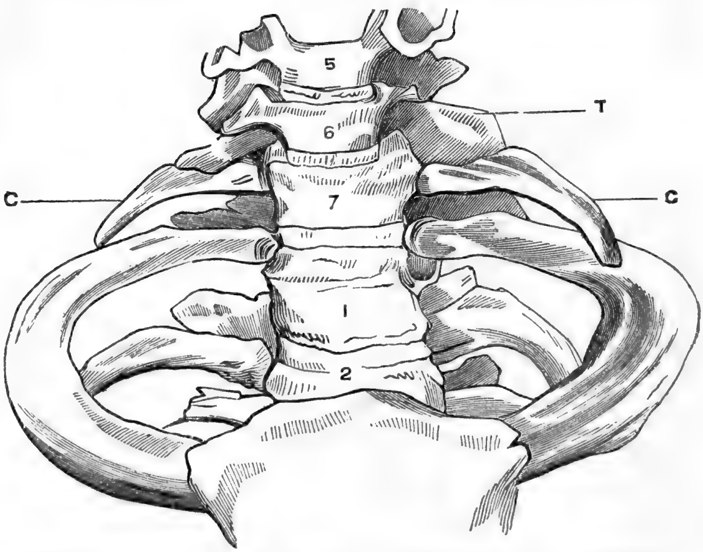

Fig. 2.—C C, cervical ribs; T, transvers process of seventh cervical vertebra.

supposed resemblance to a cuckoo's beak. Now, each trunk, or dorsal vertebra, has two ribs connected with it, one on each side; so there are altogether twenty-four ribs, twelve on each side; but sometimes there are more, and, when this occurs, the extra ribs are carried by the neck (cervical) or loin (lumbar) vertebræ. I have specimens in my collection of both varieties, cervical and lumbar (see Fig. 2, *C*). These supernumerary ribs do not occur very frequently; still, every anatomist has observed them. Their occurrence becomes more intelligible when we know that in crocodiles, birds, and the three-toed sloth, neck or cervical ribs exist normally; that in crocodiles, alligators, and some other animals, loin or lumbar ribs are never absent; and that in man traces of them exist in the muscles of the abdomen. In the human embryo, in an early stage, a rib is always seen connected with the seventh neck-vertebra, but before the fifth year of life it becomes blended with the ordinary transverse process (Fig. 2, *T*); occasionally, however, this rudiment goes on developing, till it becomes a more or less perfect cervical rib (see Fig. 2, *C*).

Supra-condyloid Process.—It is not uncommon to find, in the humerus or arm-bone of man, a hook-like process on the inner side of the lower end, having a downward direction; this, with a band of ligament which connects its tip with the humerus lower down, forms a foramen or opening through which pass the great artery and nerve of the arm (see Fig. 3, *A*, *B*). This foramen is found in about three per

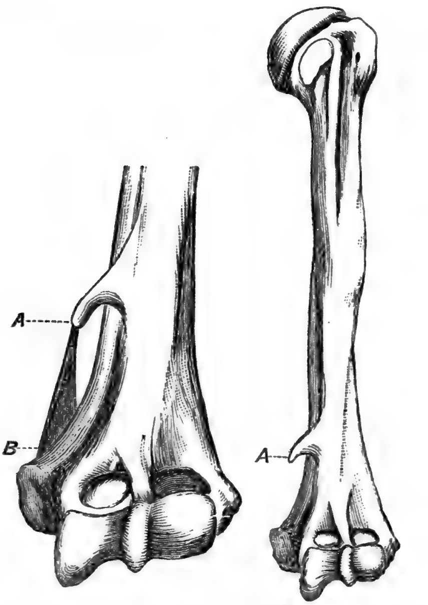

Fig. 3.—A, the supracondyloid process of the human humerus; B, the ligament which completes the foramen. (After Struthers.)

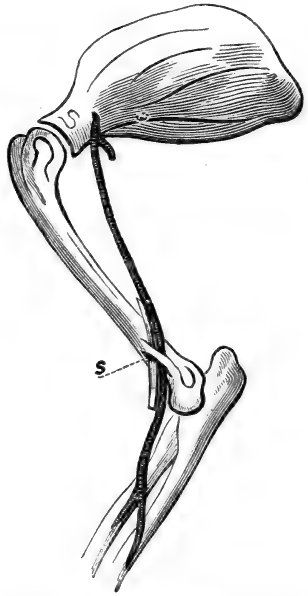

Fig. 4.—Bones of Fore-limb of Cat. S, the supracondyloid foramen, with vessel and nerve passing through. (After Struthers.)

cent of recent skeletons, but much more commonly in the skeletons of ancient races. In very many bodies a trace of this foramen is seen, represented by a very small bony prominence, or only by a band of fibrous tissue. In many of the lower animals it is the normal condition. It is seen in nearly all the carnivora, except the plantigrades (though it has been found in the cave-bear); it is also seen in monkeys, lemurs, and sloths. In these it is generally completed by bone, though in some by bone and ligament as in man. In the animals above mentioned it serves the purpose of protecting the great nerve and vessel of the fore-limb from pressure during flexion, and it also affords a more direct course by which these structures can supply the parts below (see Fig. 4). In man when this arrangement occurs, owing to the altered position of the limb, the nerve and blood-vessel are actually dragged out of their course to pass through this opening; so in him it serves no useful purpose. This variation is, as was first pointed out by Professor Struthers, well known to affect certain families. The only reasonable explanation of the occurrence of this structure appears to be that of reversion to the type of some mammalian ancestor in which this part was functional, or in other words served a definite purpose (Struthers).

Third Trochanter.—The third trochanter of the thigh-bone occurs about as frequently as the supra-condyloid process. On the upper part of the thigh-bone there are two prominences called the greater and less trochanter; a third prominence (*trochanter tertius*) sometimes occurs; it is situated a little below the great prominence, and gives attachment to the large muscle of the buttock (*glutæus maximus*). According to Fürst, in forty skeletons of Swedes examined by him in the Caroline Institute in Stockholm, fifteen possessed this process, and, in six skeletons of Laplanders, four had a third trochanter. I have seen it in only about one per cent of the skeletons I have examined. In many of the lower animals this process is enormously developed; it is very prominent in the horse and rhinoceros, and in many others it exists in a slighter degree.

One more example from the osseous system, and I shall pass to the softer structures. In the human wrist are eight small bones called carpals, and arranged in two rows; occasionally between the two rows we have a ninth bone called the os centrale. This os centrale is always present in the higher apes and some of the rodents. We also find that in every human fœtus at an early period a rudiment of this bone exists, but it has entirely disappeared by the fourth month of fetal life.

Circulatory System.—Every naturalist now admits that the various stages of development of an animal, as well as its specialized parts, are often found to correspond with permanent conditions of animals lower in the scale. A good illustration of this is seen in the development of the human heart and blood-vessels. In the early stages of development we have a heart with a single cavity, connected with a vessel at each end as in ascidians; later on the blood-vessels consist of a series of arches which go to the gills or branchial clefts as in fishes and amphibia, while the heart consists of two chambers separated by valves, and is placed far forward in the neck. The gill-arches now partly disappear, and, though the circulation still remains single as in reptiles, the heart-cavities are beginning to be separated into two distinct systems. Soon a double circulation is acquired by a complete separation of the heart into right and left. The right heart propels the venous and the left the arterial blood. At this period the condition is identical with that of birds; at last the true mammalian type of heart and blood-vessels develops and remains permanent. The arrangement of the great blood-vessels going to and from the heart varies considerably in different mammals. In man the rule is for the great artery, carrying the blood from the heart to the general system, to give off three main branches, named the innominate, left carotid, and left subclavian (see Fig. 5). These are distributed to the head and the two arms; the main vessel or aorta curves downward and distributes blood to the trunk and lower extremities. These branches are now known to be derived from certain of the original gill-arches

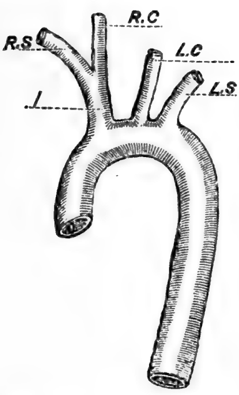

Fig. 5.—Normal Aortic Arch in Man. R. C, L. C., right and left carotid arteries going to the head; R. S., L. S., right and left subclavian arteries going to the arms; I, innominate artery.

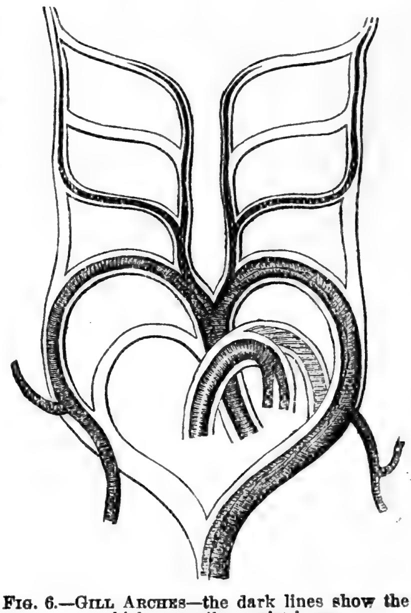

Fig. 6.—Gill Arches—the dark lines show the ones which normally persist in man.

which persist (see Fig. 6), and when any variation in their arrangement takes place it always occurs in the line of some of these gill-arches; that is, some of the arches persist which usually are obliterated. Nearly all the variations occurring in these large vessels in man are found to be the regular condition in animals lower in the scale; for instance, sometimes only two branches are given off instead of three; each of these, again, dividing into two, one for the head and one for the arm of that side (see Fig. 7, *B*). This is the usual arrangement in the bat, porpoise, and dolphin. The commonest variation of the aortic arch is where the innominate gives off the left carotid, and so supplies both sides of the head (see Fig. 7, *A*), the artery supplying the left arm coming off as usual. This is the normal condition in apes, bears, dogs, and all the feline tribe. In some rare cases in man one branch only comes off from the aortic arch, and this, again, divides into the various arteries supplying the head and arms. In horses and other solipeds, we see this form of aortic arch (see Fig. 7, *D*). Again, the branches may all be given off separately from the arch, as is the arrangement in the walrus (see Fig. 7, *C*).

I have three times met with rather a rare anomaly of the great veins going to the heart from the upper part of the body. The usual

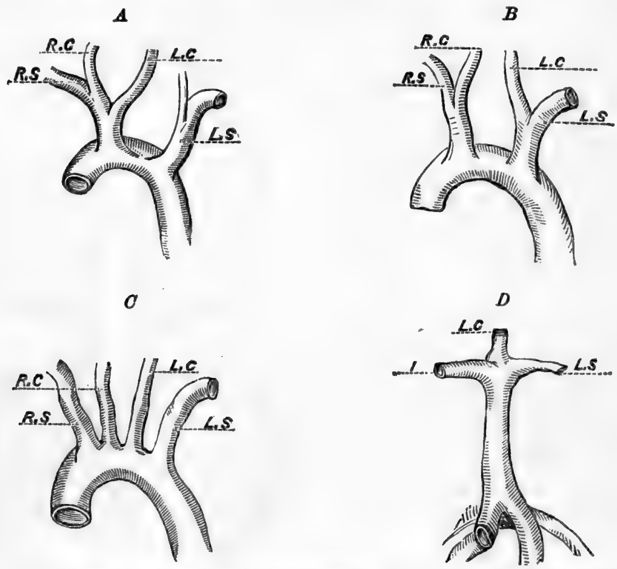

FIG. 7.—R. C., L. C., carotid arteries going to the head; R. S., L. S., subclavian arteries going to the arms; I, innominate artery.

arrangement in man, on each side, is for the great vein of one arm and the corresponding side of the head to unite and form a single trunk (brachio-cephalic), so we have two large venous trunks, one on each side; these two trunks then join to form a single large vessel, called the superior vena cava, which empties its blood into the right side of the heart (see Fig. 8, *A*). It occasionally happens that the great venous trunks formed by the veins of the arm and head of each side do not unite to form the superior vena cava, but each continues its downward course and opens separately into the heart (see Fig. 8, *B*). On studying the development of the blood-vessels, we find that in early fetal life this condition of affairs exists, but after a time a transverse branch forms between the two trunks. This branch gradually enlarges, while the left trunk shrivels up, and at birth is only represented by a fibrous cord. This anomaly of the veins we find, then, is a persistence of a usually transient fetal condition in man, and also that in all birds and many of the lower mammals it is the *permanent* condition.

Muscular System.—The muscular system of man is liable to many variations, nearly all of which are interesting from a morphological point of view.

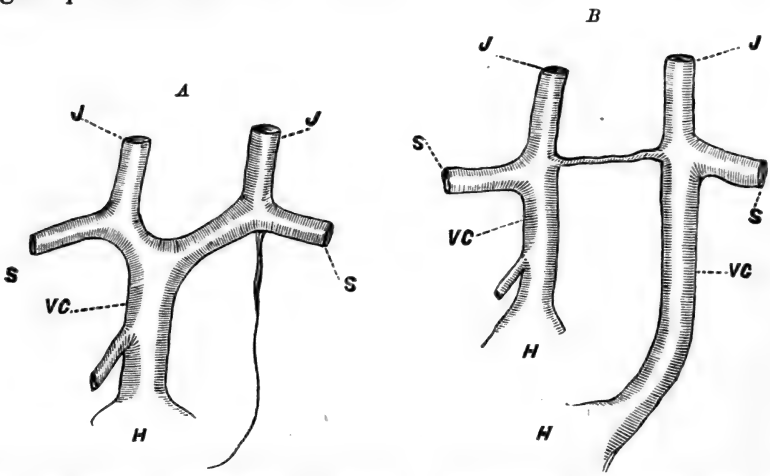

Fig. 8.—*A*, Normal Arrangement; *B*, Abnormal Arrangement. J. J., jugular veins from head; S. S., subclavian veins from arms; V. C., vena cava; H, heart.

It is not uncommon to find in man useless rudiments of muscles which exist in a well-developed state in some of our more humble fellow-creatures, and in them serve a definite purpose.

In man the "skin-muscles" are very feebly developed compared with those seen in many of the lower animals. The only remnants of these in man are, the muscle which wrinkles the forehead (*occipito-frontalis*), the muscle immediately under the skin covering the side of the neck (*platysma myoides*), and the *palmaris brevis*, a little bundle of muscular fibers in the palm of the hand; not unfrequently remnants appear abnormally in other situations, as, over the breast (see Fig. 9), in the arm-pit, on the back, etc. The skin-muscles are well developed in those of the mammalia which have loose skins, as, for example, the hedgehog, porcupine, and porpoise. In the hedgehog, when the skin-muscles contract, the animal becomes rolled up as in a bag of muscles. The sportive gambols of a school of porpoises are effected by an abundant supply of these skin-muscles; in the horse the skin-muscle is called the *panniculus carnosus*, and every one who has seen a horse twitching its skin to get rid of troublesome flies will easily understand how serviceable it is to that animal.

In all human beings there is a small muscle going from a hooked process (*coracoid*) on the upper end of the shoulder-blade to the inner side of the arm-bone about the junction of its upper and middle third. Sometimes this muscle is continued down to the lower end of the arm-bone; or, again, it may be quite short, and attached to the bag of fibrous tissue covering the shoulder-joint. On referring to the anatomy of the lower animals, it is found that both these varieties exist normally, but in a much more highly developed state; they are especially well seen in animals which use their fore-limbs for digging, climbing, or swimming. In them the muscle is of large size, and reaches to the inner edge of the lower extremity of the arm-bone; in man, when it reaches thus far, it is only rudimentary and of no use.

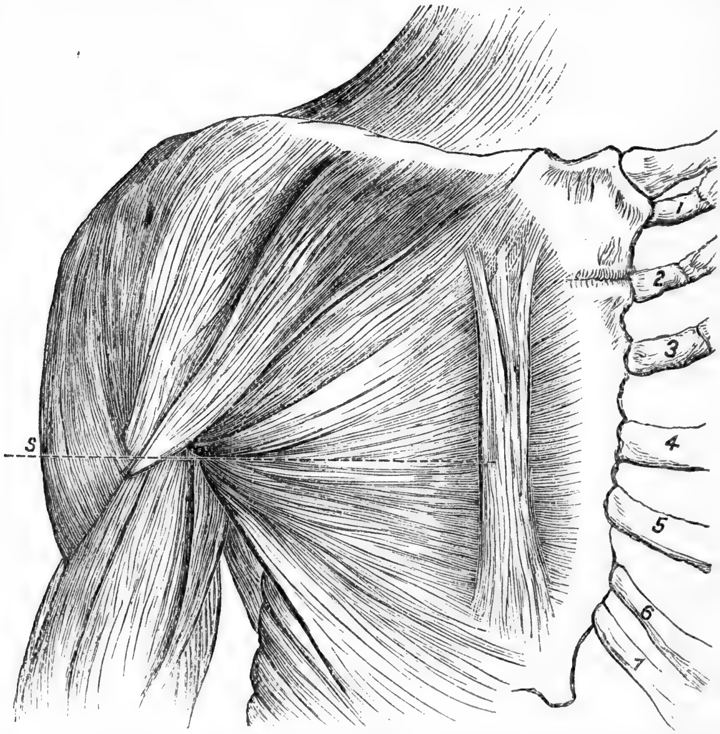

FIG. 9.—S, rectus sternalis or skin muscle, superficial to the great pectoral muscle of chest.

Another muscle which I have seen in about three per cent of human subjects is a small one which goes from the breastbone to the upper end of the shoulder-blade. This muscle is well developed in animals which have no collar-bones; it reaches its highest development in the horse, pig, hippopotamus, and elephant. It is also seen in the Guinea-pig, Norway rat, and wombat. It is quite rudimentary when it exists in man, and serves no useful purpose.

In man, near the elbow-joint, and lying close together, are two muscles going from the upper to the lower arm; one in front (*brachialis anticus*), which helps to bend the elbow, and the other to the outer side (*supinator longus*), which supinates or twists the fore-arm outward. As a rule, these muscles are quite distinct, though they lie side by side; but in about one per cent of cases they are joined together by muscular fibers. This is the normal arrangement in apes and monkeys, the union of these two muscles aiding them greatly in twisting their bodies when hanging by their fore-limbs to the branches of trees. Again, in apes, the muscle forming the posterior fold of the arm-pit is always prolonged down to the prominence on the back of the elbow. In the long-armed apes this muscle is especially well developed, and serves to swing the whole arm rapidly and powerfully forward—a movement which is of the greatest importance for dexterously grasping remote branches while in the act of climbing. The same prolongation of this muscle is occasionally seen in man, though in a much less developed state, and serves to remind him of the arboreal habits of some of his not very remote ancestors.

In the gorilla, orang, and chimpanzee a muscle, called the elevator of the collar-bone (*levator claviculæ*), is always present; this goes from the upper neck-bones to the collar-bone. It is found in about three per cent of human subjects. Other muscles, occasionally found in man in a rudimentary and fragmentary condition, are ones going from the back of the head to the collar-bone or shoulder-blade; they are well developed in many of the carnivora and ruminants. I have seen them of large size in the lion, deer, etc.; in those animals they are much used in pulling forward the shoulder.

In about every other human subject is a small muscle going from a bony spur on the front of the haunch-bones to the muscles in the anterior wall of the abdomen. This is the rudiment of the great muscle in the kangaroo, opossum, and other marsupial animals, which supports the pouch where the immature young are carried, and the bony spur is the rudiment of a distinct bone, called the marsupial bone, which always exists in these animals, and gives attachment to the muscles which open and shut the pouch.

In man the short muscle of the foot which bends the toes is attached to the heel-bone, but occasionally the portion going to the fourth and fifth toes is separated from the portion going to the second and third toes, and is attached not to the heel-bone but to the tendon of the long flexor of the toes. In the gorilla only one slip of this short flexor arises from the long flexor of the toes, but in apes we have as a normal condition the arrangement I have endeavored to describe as that occasionally seen in man.

The brain of man is distinguished from that of the gorilla and the higher apes by having a greater relative size and being more complex. The different fissures are not so continuous, and are frequently bridged over by brain-matter. In the brains of criminals, the lower races of mankind, and idiots, according to Benedict, the fissures are very confluent in character, and in some the first frontal convolution is divided into two portions, as in apes. In animals lower in the scale than man, the little brain or cerebellum is more or less uncovered by the posterior lobes of the cerebrum or large brain. This uncovered condition of the cerebellum was well seen in an idiot's brain that I lately had the privilege of examining; the fissures were also of the confluent type; the whole brain only weighed sixteen ounces. The internal organs in man, although not subject to great variations, still are sometimes found abnormal. The liver may be divided into a number of lobes, as is seen in the gorilla. This is called a degraded liver. The spleen is often deeply notched and multiple, as in the case in some of the lower animals, and the uterus is occasionally double; an arrangement which is the normal one in the mare, raccoon, rabbit, and other animals. It is double in the human fœtus up to the fourth month, and frequently a trace of this bifid condition is seen in adult life.

I could multiply, *ad infinitum*, the varietions in human anatomy which have their corresponding normal condition in the lower animals, but I think I have described a sufficient number of examples to show how common these animal resemblances are in man. On what theory can we account for their existence, except that they are reversions to some pre-existing and lower type? This is the only logical conclusion to which the study of morphology leads us, and "to take any other view," says Darwin, "is to admit that our own structure and that of all the animals around us is a mere snare laid to entrap our judgment."

MEASUREMENT OF CHARACTER.

By FRANCIS GALTON.

I DO not plead guilty to taking a shallow view of human nature, when I propose to apply, as it were, a foot-rule to its heights and depths. The powers of man are finite, and if finite they are not too large for measurement. Those persons may justly be accused of shallowness of view who do not discriminate a wide range of differences, but quickly lose all sense of proportion, and rave about infinite heights and unfathomable depths, and use such like expressions, which are not true and betray their incapacity. Examiners are not, I believe, much stricken with the sense of awe and infinitude when they apply their foot-rules to the intellectual performances of the candidates whom they examine; neither do I see any reason why we should be awed at the thought of examining our fellow-creatures as best we may in respect to other faculties than intellect. On the contrary, I think it anomalous that the art of measuring intellectual faculties should have become highly developed, while that of dealing with other qualities should have been little practiced or even considered.

The use of measuring man in his entirety is to be justified by exactly the same arguments as those by which any special examinations are justified, such as those in classics or mathematics; namely, that every measurement tests, in some particulars, the adequacy of the previous education, and contributes to show the efficiency of the man as a human machine at the time it was made. It is impossible to be sure of the adequacy in every respect of the rearing of a man, or of his total efficiency, unless he has been measured in character and physique, as well as in intellect. A wise man desires this knowledge for his own use, and for the same reason that he takes stock from time to time of his finances. It teaches him his position among his fellows, and whether he is getting on or falling back, and he shapes his ambitions and conduct accordingly. "Know thyself" is an ancient phrase of proverbial philosophy, and I wish to discuss ways by which its excellent direction admits of being better followed.

The art of measuring various human faculties now occupies the attention of many inquirers in this and other countries. Shelves full of memoirs have been written in Germany alone, on the discriminative powers of the various senses. New processes of inquiry are yearly invented, and it seems as though there was a general lightening up of the sky in front of the path of the anthropometric experimenter, which betokens the approaching dawn of a new and interesting science. Can we discover landmarks in character to serve as bases for a survey, or is it altogether too indefinite and fluctuating to admit of measurement? Is it liable to spontaneous changes, or to be in any way affected by a caprice that renders the future necessarily uncertain? Is man, with his power of choice and freedom of will, so different from a conscious machine that any proposal to measure his moral qualities is based upon a fallacy? If so, it would be ridiculous to waste thought on the matter; but if our temperament and character are durable realities, and persistent factors of our conduct, we have no Proteus to deal with in either case, and our attempts to grasp and measure them are reasonable.

I have taken pains, as some of my readers may be aware, to obtain fresh evidence upon this question, which, in other words, is whether or not the actions of men are mainly governed by cause and effect. On the supposition that they are so governed, it is as important to us to learn the exact value of our faculties as it is to know the driving power of the engine and the quality of the machine that does our factory-work. If, on the other hand, the conduct of man is mainly the result of mysterious influences, such knowledge is of little service to him. He must be content to look upon himself as on a ship, afloat in a strong and unknown current, that may drift her in a very different direction to that in which her head is pointed.

My earlier inquiries into this subject had reference to the facts of heredity, and I came across frequent instances in which a son, happening to inherit somewhat exclusively the qualities of his father, had been found to fail with his failures, sin with his sins, surmount with his virtues, and generally to get through life in much the same way. The course of his life had, therefore, been predetermined by his inborn faculties, or, to continue the previous metaphor, his ship had not drifted, but pursued the course in which her head was set until she arrived at her predestined port.

The second of my inquiries was into the life-histories of twins, in the course of which I collected cases where the pair of twins resembled each other so closely that they behaved like one person, thought and spoke alike, and acted similar parts when separated. Whatever spontaneous feeling the one twin may have had, the other twin at the very same moment must have had a spontaneous feeling of exactly the same kind. Such habitual coincidences, if they had no common cause, would be impossible; we are therefore driven to the conclusion that, whenever twins think and speak alike, there is no spontaneity in either of them, in the popular acceptation of the word, but that they act mechanically and in like ways, because their mechanisms are alike. I need not reiterate my old arguments, and will say no more about the twins, except that new cases have come to my knowledge which corroborate former information. It follows that, if we had in our keeping the twin of a man, who was his "double," we might obtain a trustworthy forecast of what the man would do under any new conditions, by first subjecting that twin to the same conditions and watching his conduct.

My third inquiry is more recent. It was a course of introspective search into the operations of my own mind, whenever I caught myself engaged in a feat of what at first sight seemed to be free-will. The inquiry was carried on almost continuously for three weeks, and proceeded with, off and on, for many subsequent months. After I had mastered the method of observation, a vast deal of apparent mystery cleared away, and I ultimately reckoned the rate of occurrence of perplexing cases, during the somewhat uneventful but pleasant months of a summer spent in the country, to be less than one a day. All the rest of my actions seemed clearly to lie within the province of normal cause and consequence. The general results of my introspective inquiry support the views of those who hold that man is little more than a conscious machine, the larger part of whose actions are predicable. As regards such residuum as there may be, which is not automatic, and which a man, however wise and well-informed, could not possibly foresee, I have nothing to say; but I have found that the more carefully I inquired, whether it was into hereditary similarities of conduct, into the life-histories of twins, or now introspectively into the processes of what I should have called my own free-will, the smaller seems the room left for the possible residuum.

I conclude from these three inquiries that the motives of the will are mostly normal, and that the character which shapes our conduct is a definite and durable "something," and therefore that it is reasonable to attempt to measure it. We must guard ourselves against supposing that the moral faculties which we distinguish by different names, as courage, sociability, niggardliness, are separate entities. On the contrary, they are so intermixed that they are never singly in action. I tried to gain an idea of the number of the more conspicuous aspects of the character by counting in an appropriate dictionary the words used to express them. Roget's "Thesaurus" was selected for that purpose, and I examined many pages of its index here and there as samples of the whole, and estimated that it contained fully one thousand words expressive of character, each of which has a separate shade of meaning, while each shares a large part of its meaning with some of the rest.

It may seem hopeless to deal accurately with so vague and wide a subject, but it often happens that, when we are unable to meet difficulties, we may evade them, and so it is with regard to the present difficulty. It is true that we can not define any aspect of character, but we can define a test that shall elicit *some* manifestation of character, and we can define the act performed in response to it. Searchings into the character must be conducted on the same fundamental principle as that which lies at the root of examinations into the intellectual capacity. Here there has been no preliminary attempt to map out the field of intellect with accuracy; but definite tests are selected by which the intellect is probed at places that are roughly known but not strictly defined, as the depth of a lake might be sounded from a boat rowing here and there. So it should be with respect to character. Definite acts in response to definite emergencies have alone to be noted. No accurate map of character is required to start from.

Emergencies need not be waited for, they can be extemporized; traps, as it were, can be laid. Thus, a great ruler, whose word can make or mar a subject's fortune, wants a secret agent, and tests his character during a single interview. He contrives by a few minutes' questioning, temptation, and show of displeasure, to turn his character inside out, exciting in turns his hopes, fear, zeal, loyalty, ambition, and so forth. Ordinary observers, who stand on a far lower pedestal, can not hope to excite the same tension and outburst of feeling in those whom they examine, but they can obtain good data in a more leisurely way. If they are unable to note a man's conduct under great trials for want of opportunity, they may do it in small ones, and it is well that those small occasions should be such as are of frequent occurrence, that the statistics of men's conduct under like conditions may be compared. After fixing upon some particular class of persons of similar age, sex, and social condition, we have to find out what common incidents in their lives are most apt to make them betray their character. We may then take note, as often as we can, of what they do on these occasions, so as to arrive at their statistics of conduct in a limited number of well-defined small trials.

One of the most notable differences between man and man lies in the emotional temperament. Some persons are quick and excitable; others are slow and deliberate. A sudden excitement, call, touch, gesture, or incident of any kind evokes, in different persons, a response that varies in intensity, celerity, and quality. An observer watching children, heart and soul at their games, would soon collect enough material to enable him to class them according to the quantity of emotion that they showed. I will not attempt to describe particular games of children or of others, nor to suggest experiments, more or less comic, that might be secretly made to elicit the manifestations we seek, as many such will occur to ingenious persons. They exist in abundance, and I feel sure that, if two or three experimenters were to act zealously and judiciously together as secret accomplices, they would soon collect abundant statistics of conduct. They would gradually simplify their test conditions and extend their scope, learning to probe character more quickly and from more of its sides.

It is a question by no means to be decided off-hand in the negative, whether instrumental measurements of the magnitude of the reflex signs of emotion in persons who desire to submit themselves to experiment are not feasible. The difficulty lies in the more limited range of tests that can be used when the freedom of movement is embarrassed by the necessary mechanism. The exciting cause of emotion, whatever it be, a fright, a suspense, a scold, an insult, a grief, must be believed to be genuine, or the tests would be worthless. It is not possible to sham emotion thoroughly. A good actor may move his audience as deeply as if they were witnessing a drama of real life, but the best actor can not put himself into the exact frame of mind of a real sufferer. If he did, the reflex and automatic signs of emotion excited in his frame would be so numerous and violent that they would shatter his constitution long before he had acted a dozen tragedies.

The reflex signs of emotion that are perhaps the most easily registered are the palpitations of the heart. They can not be shammed or repressed, and they are visible. Our poet-laureate has happily and artistically exemplified this. He tells us that Launcelot, returning to court after a long illness, through which he had been nursed by Elaine, sent to crave an audience of the jealous queen. The messenger utilizes the opportunity for observing her in the following ingenious way like a born scientist:

> "Low drooping till he well-nigh kissed her feet
> For loyal awe, saw with a sidelong eye
> The shadow of a piece of pointed lace
> In the queen's shadow, vibrate on the wall,
> And parted, laughing in his courtly heart."

Physiological experimenters are not content to look at shadows on the wall, that depart and leave no mark. They obtain durable traces by the aid of appropriate instruments. Maret's pretty little pneumocardiograph is very portable, but not so sure in action as the more bulky apparatus. It is applied tightly to the chest in front of the heart, by a band passing round the body. At each to-and-fro movement, whether of the chest as a whole, or of the portion over the heart, it sucks in or blows out a little puff of air. A thin India-rubber tube connects its nozzle with a flat elastic bag under the short arm of a lever. The other end of the lever moves up and down in accordance with the part of the chest to which the pneumo-cardiograph is applied, and scratches light marks on a band of paper which is driven onward by clock-work. This little instrument can be worn under the buttoned coat without being noticed. I was anxious to practice myself in its use, and wore one during the formidable ordeal of delivering the Rede Lecture in the senate-house at Cambridge, a month ago (most of this very memoir forming part of that lecture). I had no connection established between my instrument and any recording apparatus, but wore it merely to see whether or not it proved in any way irksome. If I had had a table in front of me, with the recording apparatus stowed out of sight below, and an expert assistant near at hand to turn a stop-cock at appropriate moments, he could have obtained samples of my heart's action without causing me any embarrassment whatever. I should have forgotten all about the apparatus while I was speaking.

Instrumental observers of the reflex signs of emotion have other means available besides this, and the sphygmograph that measures the pulse. Every twitch of each separate finger even of an infant's hand is registered by Dr. Warner's ingenious little gauntlet. Every movement of each limb of man or horse is recorded by Dr. Maret. The apparatus of Mosso measures the degree in which the blood leaving the extremities rushes to the heart and head and internal organs. Every limb shrinks sensibly in volume from this withdrawal of the blood, and the shrinkage of any one of them, say the right arm, is measured by the fall of water in a gauge that communicates with a long bottleful of water, through the neck of which the arm has been thrust, and in which it is softly but effectually plugged.

I should not be surprised if the remarkable success of many persons in "muscle-reading" should open out a wide field for delicate instrumental investigations. The poetical metaphors of ordinary language suggest many possibilities of measurement. Thus, when two persons have an "inclination" to one another, they visibly incline or slope together when sitting side by side, as at a dinner-table, and they then throw the stress of their weights on the near legs of their chairs. It does not require much ingenuity to arrange a pressure-gauge with an index and dial to indicate changes in stress, but it is difficult to devise an arrangement that shall fulfill the threefold condition of being effective, not attracting notice, and being applicable to ordinary furniture. I made some rude experiments, but, being busy with other matters, have not carried them on, as I had hoped.

Another conspicuous way in which one person differs from another is in temper. Some men are easily provoked, others remain cheerful even when affairs go very contrary to their liking. We all know specimens of good and bad-tempered persons, and all of us could probably specify not a few approriate test conditions to try the temper in various ways, and elicit definite responses. There is no doubt that the temper of a dog can be tested. Many boys do it habitually, and learn to a nicety how much each will put up with, without growling or showing other signs of resentment. They do the same to one another, and gauge each other's tempers accurately.

It is difficult to speak of tests of character without thinking of Benjamin Franklin's amusing tale of the "Handsome and the Deformed Leg," and there is no harm in quoting it, because, however grotesque, it exemplifies the principle of tests. In it he describes two sorts of people ; those who habitually dwell on the pleasanter circumstances of the moment, and those who have no eyes but for the unpleasing ones. He tells how a philosophical friend took special precautions to avoid those persons who, being discontented themselves, sour the pleasures of society, offend many people, and make themselves everywhere disagreeable. In order to discover a pessimist at first sight, he cast about for an instrument. He of course possessed a thermometer to test heat, and a barometer to tell the air-pressure, but he had no instrument to test the characteristic of which we are speaking. After much pondering he hit upon a happy idea. He chanced to have one remarkably handsome leg, and one that by some accident was crooked and deformed, and these he used for the purpose. If a stranger regarded his ugly leg more than his handsome one, he doubted him. If he spoke of it and took no notice of the handsome leg, the philosopher determined to avoid his further acquaintance. Franklin sums up by saying that every one has not this two-legged instrument, but every one with a little attention may observe the signs of a carping and fault-finding disposition.

This very disposition is the subject of the eighteenth "character" of Theophrastus, who describes the conduct of such men under the social conditions of the day, one of which is also common to our own time and countrymen. He says that when the weather has been very dry for a long time, and it at last changes, the grumbler, being unable to complain of the rain, complains that it did not come sooner. The British philosopher has frequent opportunities for applying weather tests to those whom he meets, and with especial fitness to such as happen to be agriculturists.

The points I have endeavored to impress are chiefly these : First, that character ought to be measured by carefully recorded acts, representative of the usual conduct. An ordinary generalization is nothing more than a muddle of vague memories of inexact observations. It is an easy vice to generalize. We want lists of facts, every one of which may be separately verified, valued, and revalued, and the whole accurately summed. It is the statistics of each man's conduct in small, every-day affairs that will probably be found to give the simplest and most precise measure of his character. The other chief point that I wish to impress is, that a practice of deliberately and methodically testing the character of others and of ourselves is not wholly fanciful, but deserves consideration and experiment.—*Fortnightly Review.*

THE RECENT PROGRESS OF PHYSICAL SCIENCE.*

By Professor LORD RAYLEIGH.

LADIES AND GENTLEMEN : It is no ordinary meeting of the British Association which I have now the honor of addressing. For more than fifty years the Association has held its autumn gathering in various towns of the United Kingdom, and within those limits there is, I suppose, no place of importance which we have not visited. And now, not satisfied with past successes, we are seeking new worlds to conquer. When it was first proposed to visit Canada, there were some who viewed the project with hesitation. For my own part, I never quite understood the grounds of their apprehension. Perhaps they feared the thin edge of the wedge. When once the principle was admitted, there was no knowing to what it might lead. So rapid is the development of the British Empire, that the time might come when a visit to such out-of-the-way places as London or Manchester could no longer be claimed as a right, but only asked for as a concession to the susceptibilities of the English. But, seriously, whatever objections may have at first been felt soon were outweighed by the consideration of the magnificent opportunities which your hospitality affords of extending the sphere of our influence and of becoming acquainted with a part of the Queen's dominion which, associated with splendid memories of the past, is advancing daily by leaps and bounds to a position of importance such as not long ago was scarcely dreamed of. For myself, I am not a stranger to your shores. I remember well the impression made upon me, seventeen years ago, by the wild rapids of the St. Lawrence, and the gloomy grandeur of the Saguenay. If anything impressed me more, it was the kindness with which I was received by yourselves, and which I doubt not will be again extended not merely to myself but to all the English members of the Association. I am confident that those who have made up their minds to cross the ocean will not repent their decision, and that, apart altogether from scientific interests, great advantage may be expected from this visit. We Englishmen ought to know more than we do of matters relating to the colonies, and anything which tends to bring the various parts of the empire into closer contact can hardly be over-

* Inaugural address of the President of the British Association for the Advancement of Science, delivered at Montreal, August 27, 1884.

valued. It is pleasant to think that this Association is the means of furthering an object which should be dear to the hearts of all of us; and I venture to say that a large proportion of the visitors to this country will be astonished by what they see, and will carry home an impression which time will not readily efface.

To be connected with this meeting is, to me, a great honor, but also a great responsibility. In one respect, especially, I feel that the Association might have done well to choose another president. My own tastes have led me to study mathematics and physics rather than geology and biology, to which naturally more attention turns in a new country, presenting as it does a fresh field for investigation. A chronicle of achievements in these departments by workers from among yourselves would have been suitable to the occasion, but could not come from me. If you would have preferred a different subject for this address, I hope, at least, that you will not hold me entirely responsible.

At annual gatherings like ours the pleasure with which friends meet friends again is sadly marred by the absence of those who can never more take their part in our proceedings. Last year my predecessor in this office had to lament the untimely loss of Spottiswoode and Henry Smith, dear friends of many of us, and prominent members of our Association. And now, again, a well-known form is missing. For many years Sir W. Siemens has been a regular attendant at our meetings, and to few indeed have they been more indebted for success. Whatever the occasion, in his Presidential Address of two years ago, or in communications to the Physical and Mechanical Sections, he had always new and interesting ideas, put forward in language which a child could understand, so great a master was he of the art of lucid statement in his adopted tongue. Practice with science was his motto. Deeply engaged in industry, and conversant all his life with engineering operations, his opinion was never that of a mere theorist. On the other hand, he abhorred rule of thumb, striving always to master the scientific principles which underlie rational design and invention.

It is not necessary that I should review in detail the work of Siemens. The part which he took, during recent years, in the development of the dynamo-machine must be known to many of you. We owe to him the practical adoption of the method, first suggested by Wheatstone, of throwing into a shunt the coils of the field-magnets, by which a greatly improved steadiness of action is obtained. The same characteristics are observable throughout—a definite object in view and a well-directed perseverance in overcoming the difficulties by which the path is usually obstructed.

These are, indeed, the conditions of successful invention. The world knows little of such things, and regards the new machine or the new method as the immediate outcome of a happy idea. Probably, if the truth were known, we should see that, in nine cases out of ten, success depends as much upon good judgment and perseverance as upon fertility of imagination. The labors of our great inventors are not unappreciated, but I doubt whether we adequately realize the enormous obligations under which we lie. It is no exaggeration to say that the life of such a man as Siemens is spent in the public service; the advantages which he reaps for himself being as nothing in comparison with those which he confers upon the community at large.

As an example of this it will be sufficient to mention one of the most valuable achievements of his active life—his introduction, in conjunction with his brother, of the regenerative gas-furnace, by which an immense economy of fuel (estimated at millions of tons annually) has been effected in the manufacture of steel and glass. The nature of this economy is easily explained. Whatever may be the work to be done by the burning of fuel, a certain *temperature* is necessary. For example, no amount of heat in the form of boiling water would be of any avail for the fusion of steel. When the products of combustion are cooled down to the point in question, the heat which they still contain is useless as regards the purpose in view. The importance of this consideration depends entirely upon the working temperature. If the object be the evaporation of water or the warming of a house, almost all the heat may be extracted from the fuel without special arrangements. But it is otherwise when the temperature required is not much below that of combustion itself, for then the escaping gases carry away with them the larger part of the whole heat developed. It was to meet this difficulty that the regenerative-furnace was devised. The products of combustion, before dismissal into the chimney, are caused to pass through piles of loosely stacked fire-brick, to which they give up their heat. After a time the fire-brick, upon which the gases first impinge, becomes nearly as hot as the furnace itself. By suitable valves the burned gases are then diverted through another stack of brick-work, which they heat up in like manner, while the heat stored up in the first stack is utilized to warm the unburned gas and air on their way to the furnace. In this way almost all the heat developed at a high temperature during the combustion is made available for the work in hand.

As it is now several years since your presidential chair has been occupied by a professed physicist, it may naturally be expected that I should attempt some record of recent progress in that branch of science, if, indeed, such a term be applicable. For it is one of the difficulties of the task that subjects as distinct as mechanics, electricity, heat, optics, and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the life-long attention of a man of science, and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Not that I would complain of the association sanctioned by common parlance. A sound knowledge of at least the principles of general physics is necessary to the cultivation of any department. The predominance of the sense of sight as the medium of communication with the outer world brings with it dependence upon the science of optics; and there is hardly a branch of science in which the effects of *temperature* have not (often without much success) to be reckoned with. Besides, the neglected border-land between two branches of knowledge is often that which best repays cultivation, or, to use a metaphor of Maxwell's, the greatest benefits may be derived from a cross-fertilization of the sciences. The wealth of material is an evil only from the point of view of one of whom too much may be expected. Another difficulty incident to the task, which must be faced but can not be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterward have taken root downward and borne much fruit upward.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale—a subject to which I have already had occasion to allude in connection with the work of Sir W. Siemens. The dynamo-machine is, indeed, founded upon discoveries of Faraday now more than half a century old; but it has required the protracted labors of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow. I do not refer to details of design, the elaboration of which must always, I suppose, require the experience of actual work to indicate what parts are structurally weaker than they should be, or are exposed to undue wear and tear. But, with regard to the main features of the problem, it would almost seem as if the difficulty lay in want of faith. Long ago it was recognized that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one can not help thinking that, if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious when regarded from the stand-point of accomplished fact, and I draw attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of Nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum —not more than about one-millionth of the normal quantity of air should remain—and it is interesting to recall that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial scale and intrusted to the hands of ordinary workmen.

When I speak in hopeful language of practical electricity, I do not forget the disappointment within the last year or two of many over-sanguine expectations. The enthusiasm of the inventor and promoter is necessary to progress, and it seems to be almost a law of Nature that it should overpass the bounds marked out by reason and experience. What is most to be regretted is the advantage taken by speculators of the often uninstructed interest felt by the public in novel schemes by which its imagination is fired. But, looking forward to the future of electric lighting, we have good ground for encouragement. Already the lighting of large passenger-ships is an assured success, and one which will be highly appreciated by those travelers who have experienced the tedium of long winter evenings unrelieved by adequate illumination. Here, no doubt, the conditions are in many respects especially favorable. As regards space, life on board ship is highly concentrated; while unity of management and the presence on the spot of skilled engineers obviate some of the difficulties that are met with under other circumstances. At present we have no experience of a house-to-house system of illumination on a great scale and in competition with cheap gas; but preparations are already far advanced for trial on an adequate scale in London. In large institutions, such as theatres and factories, we all know that electricity is in successful and daily extending operation.

When the necessary power can be obtained from the fall of water, instead of from the combustion of coal, the conditions of the problem are far more favorable. Possibly the severity of your winters may prove an obstacle, but it is impossible to regard your splendid river without the thought arising that the day may come when the vast powers now running to waste shall be bent into your service. Such a project demands, of course, the most careful consideration, but it is one worthy of an intelligent and enterprising community.

The requirements of practice react in the most healthy manner upon scientific electricity. Just as in former days the science received a stimulus from the application to telegraphy, under which everything relating to measurement on a small scale acquired an importance and development for which we might otherwise have had long to wait, so now the requirements of electric lighting are giving rise to a new development of the art of measurement upon a large scale, which can not fail to prove of scientific as well as practical importance. Mere change of scale may not at first appear a very important matter, but it is surprising how much modification it entails in the instruments, and in the processes of measurement. For instance, the resistance-coils on which the electrician relies in dealing with currents whose maximum is a fraction of an ampère, fail altogether when it becomes a question of hundreds, not to say thousands, of ampères.

The powerful currents which are now at command constitute almost a new weapon in the hands of the physicist. Effects, which in old days were rare and difficult of observation, may now be produced at will on the most conspicuous scale. Consider, for a moment, Faraday's great discovery of the "magnetization of light," which Tyndall likens to the Weisshorn among mountains, as high, beautiful, and alone. This judgment (in which I fully concur) relates to the scientific aspect of the discovery, for to the eye of sense nothing could have been more insignificant. It is even possible that it might have eluded altogether the penetration of Faraday, had he not been provided with a special quality of very heavy glass. At the present day these effects may be produced upon a scale that would have delighted their discoverer, a rotation of the plane of polarization through 180° being perfectly feasible. With the aid of modern appliances, Kundt and Röntgen, in Germany, and H. Becquerel, in France, have detected the rotation in gases and vapors, where, on account of its extreme smallness, it had previously escaped notice.

Again, the question of the magnetic saturation of iron has now an importance entirely beyond what it possessed at the time of Joule's early observations. Then it required special arrangements purposely contrived to bring it into prominence. Now in every dynamo-machine the iron of the field-magnets approaches a state of saturation, and the very elements of an explanation of the action require us to take the fact into account. It is, indeed, probable that a better knowledge of this subject might lead to improvements in the design of these machines.

Notwithstanding the important work of Rowland and Stoletow, the whole theory of the behavior of soft iron under varying magnetic conditions is still somewhat obscure. Much may be hoped from the induction-balance of Hughes, by which the marvelous powers of the telephone are applied to the discrimination of the properties of metals, as regards magnetism and electric conductivity.

The introduction of powerful alternate-current in machines by Siemens, Gordon, Ferranti, and others, is likely also to have a salutary effect in educating those so-called practical electricians whose ideas do not easily rise above ohms and volts. It has long been known that, when the changes are sufficiently rapid, the phenomena are governed much more by induction, or electric inertia, than by mere resistance. On this principle much may be explained that would otherwise seem paradoxical. To take a comparatively simple case, conceive an electro-magnet wound with two contiguous wires, upon which acts a given rapidly periodic electro-motive force. If one wire only be used, a certain amount of heat is developed in the circuit. Suppose now that the second wire is brought into operation in parallel—a proceeding equivalent to doubling the section of the original wire. An electrician, accustomed only to constant currents, would be sure to think that the heating effect would be doubled by the change, as much heat being developed in each wire separately as was at first in the single wire. But such a conclusion would be entirely erroneous. The total current, being governed practically by the self-induction of the circuit, would not be augmented by the accession of the second wire, and the total heating effect, so far from being doubled, would, in virtue of the superior conductivity, be halved.

During the last few years much interest has been felt in the reduction to an absolute standard of measurements of electro-motive force, current, resistance, etc., and to this end many laborious investigations have been undertaken. The subject is one that has engaged a good deal of my own attention, and I should naturally have felt inclined to dilate upon it, but that I feel it to be too abstruse and special to be dealt with in detail upon an occasion like the present. As regards resistance, I will merely remind you that the recent determinations have shown a so greatly improved agreement that the Conference of Electricians assembled at Paris, in May, have felt themselves justified in defining the ohm, for practical use, as the resistance of a column of mercury of 0° C., one square millimetre in section, and 106 centimetres in length—a definition differing by a little more than one per cent from that arrived at twenty years ago by a committee of this Association.

A standard of resistance once determined upon can be embodied in a "resistance-coil," and copied without much trouble, and with great accuracy. But, in order to complete the electrical system, a second standard of some kind is necessary, and this is not so easily embodied in a permanent form. It might conveniently consist of a standard galvanic cell, capable of being prepared in a definite manner, whose electro-motive force is once for all determined. Unfortunately, most of the batteries in ordinary use are, for one reason or another, unsuitable for this purpose, but the cell introduced by Mr. Latimer Clark, in which the metals are zinc in contact with saturated zinc sulphate and pure mercury in contact with mercurous sulphate, appears to give satisfactory results. According to my measurements, the electro-motive force of this cell is 1·435 theoretical volt.

We may also conveniently express the second absolute electrical measurement necessary to the completion of the system by taking advantage of Faraday's law, that the quantity of metal decomposed in an electrolytic cell is proportional to the whole quantity of electricity that passes. The best metal for the purpose is silver, deposited from a solution of the nitrate or of the chlorate. The results recently obtained by Professor Kohlrausch and by myself are in very good agreement, and the conclusion that one ampère flowing for one hour decomposes 4·025 grains of silver, can hardly be in error by more than a thousandth part. This number being known, the silver voltameter gives a ready and very accurate method of measuring currents of intensity, varying from $\frac{1}{10}$ ampère to four or five ampères.

The beautiful and mysterious phenomena attending the discharge of electricity in nearly vacuous spaces have been investigated, and in some degree explained, by De La Rue, Crookes, Schuster, Moulton, and the lamented Spottiswoode, as well as by various able foreign experimenters. In a recent research Crookes has sought the origin of a bright citron-colored band in the phosphorescent spectrum of certain earths, and, after encountering difficulties and anomalies of a most bewildering kind, has succeeded in proving that it is due to yttrium, an element much more widely distributed than had been supposed. A conclusion like this is stated in a few words, but those only who have undergone similar experience are likely to appreciate the skill and perseverance of which it is the final reward.

A remarkable observation by Hall, of Baltimore, from which it appeared that the flow of electricity in a conducting sheet was disturbed by magnetic force, has been the subject of much discussion. Mr. Shelford Bidwell has brought forward experiments tending to prove that the effect is of a secondary character, due, in the first instance, to the mechanical force operating upon the conductor of an electric current when situated in a powerful magnetic field. Mr. Bidwell's view agrees in the main with Mr. Hall's division of the metals into two groups according to the direction of the effect.

Without doubt the most important achievement of the older generation of scientific men has been the establishment and application of the great laws of thermo-dynamics, or, as it is often called, the mechanical theory of heat. The first law, which asserts that heat and mechanical work can be transformed one into the other at a certain fixed rate, is now well understood by every student of physics, and the number expressing the mechanical equivalent of heat resulting from the experiments of Joule has been confirmed by the researches of others, and especially of Rowland. But the second law, which practically is even more important than the first, is only now beginning to receive the full appreciation due to it. One reason of this may be found in a not unnatural confusion of ideas. Words do not always lend themselves readily to the demands that are made upon them by a growing science, and I think that the almost unavoidable use of the word equivalent, in the statement of the first law, is partly responsible for the little attention that is given to the second. For the second law so far contradicts the usual statement of the first as to assert that equivalents of heat and work are not of equal value. While work can always be converted into heat, heat can only be converted into work under certain limitations. For every practical purpose the work is worth the most, and when we speak of equivalents we use the word in the same sort of special sense as that in which chemists speak of equivalents of gold and iron. The second law teaches us that the real value of heat, as a source of mechanical power, depends upon the temperature of the body in which it resides; the hotter the body in relation to its surroundings, the more available the heat.

In order to see the relations which obtain between the first and the second law of thermo-dynamics, it is only necessary for us to glance at the theory of the steam-engine. Not many years ago calculations were plentiful, demonstrating the inefficiency of the steam-engine on the basis of a comparison of the work actually got out of the engine with the mechanical equivalent of the heat supplied to the boiler. Such calculations took into account only the first law of thermo-dynamics, which deals with the equivalents of heat and work, and have very little bearing upon the practical question of efficiency, which requires us to have regard also to the second law. According to that law, the fraction of the total energy which can be converted into work depends upon the relative temperatures of the boiler and condenser; and it is, therefore, manifest that, as the temperature of the boiler can not be raised indefinitely, it is impossible to utilize all the energy which, according to the first law of thermo-dynamics, is resident in the coal.

On a sounder view of the matter, the efficiency of the steam-engine is found to be so high that there is no great margin remaining for improvement. The higher initial temperature possible in the gas-engine opens out much wider possibilities, and many good judges look forward to a time when the steam-engine will have to give way to its younger rival.

To return to the theoretical question, we may say with Sir W. Thomson that, though energy can not be destroyed, it ever tends to be dissipated, or to pass from more available to less available forms. No one who has grasped this principle can fail to recognize its immense importance in the system of the universe. Every change—chemical, thermal, or mechanical—which takes place, or can take place, in Nature does so at the cost of a certain amount of available energy. If, therefore, we wish to inquire whether or not a proposed transformation can take place, the question to be considered is whether its occurrence would involve dissipation of energy. If not, the transformation is (under the circumstances of the case) absolutely excluded. Some years ago, in a lecture at the Royal Institution, I endeavored to draw the attention of chemists to the importance of the principle of dissipation in relation to their science, pointing out the error of the usual assumption that a general criterion is to be found in respect of the development of heat. For example, the solution of a salt in water is, if I may be allowed the phrase, a down-hill transformation. It involves dissipation of energy, and can therefore go forward; but in many cases it is associated with the absorption rather than with the development of heat. I am glad to take advantage of the present opportunity in order to repeat my recommendation, with an emphasis justified by actual achievement. The foundations laid by Thomson now bear an edifice of no mean proportions, thanks to the labors of several physicists, among whom must be especially mentioned Willard Gibbs and Helmholtz. The former has elaborated a theory of the equilibrium of heterogeneous substances, wide in its principles, and we can not doubt far-reaching in its consequences. In a series of masterly papers Helmholtz has developed the conception of *free energy* with very important applications to the theory of the galvanic cell. He points out that the mere tendency to solution bears in some cases no small proportion to the affinities more usually reckoned chemical, and contributes largely to the total electro-motive force. Also in our own country Dr. Alder Wright has published some valuable experiments relating to the subject.

From the further study of electrolysis we may expect to gain improved views as to the nature of the chemical reactions, and of the forces concerned in bringing them about. I am not qualified—I wish I were—to speak to you on recent progress in general chemistry. Perhaps my feelings toward a first love may blind me, but I can not help thinking that the next great advance, of which we have already some foreshadowing, will come on this side. And if I might without presumption venture a word of recommendation, it would be in favor of a more minute study of the simpler chemical phenomena.

Under the head of scientific mechanics it is principally in relation to fluid motion that advances may be looked for. In speaking upon this subject I must limit myself almost entirely to experimental work. Theoretical hydro-dynamics, however important and interesting to the mathematician, are eminently unsuited to oral exposition. All I can do to attenuate an injustice, to which theorists are pretty well accustomed, is to refer you to the admirable reports of Mr. Hicks, published under the auspices of this Association.

The important and highly practical work of the late Mr. Froude in relation to the propulsion of ships is doubtless known to most of you. Recognizing the fallacy of views then widely held as to the nature of the resistance to be overcome, he showed to demonstration that, in the case of fair-shaped bodies, we have to deal almost entirely with resistance dependent upon skin-friction, and at high speeds upon the generation of surface-waves by which energy is carried off. At speeds which are moderate in relation to the size of the ship, the resistance is practically dependent upon skin-friction only. Although Professor Stokes and other mathematicians had previously published calculations pointing to the same conclusion, there can be no doubt that the view generally entertained was very different. At the first meeting of the Association which I ever attended, as an intelligent listener, at Bath, in 1864, I well remember the surprise which greeted a statement by Rankine that he regarded skin-friction as the only legitimate resistance to the progress of a well-designed ship. Mr. Froude's experiments have set the question at rest in a manner satisfactory to those who had little confidence in theoretical prevision.

In speaking of an explanation as satisfactory in which skin-friction is accepted as the cause of resistance, I must guard myself against being supposed to mean that the nature of skin-friction is itself well understood. Although its magnitude varies with the smoothness of the surface, we have no reason to think that it would disappear at any degree of smoothness consistent with an ultimate molecular structure. That it is connected with fluid viscosity is evident enough, but the *modus operandi* is still obscure.

Some important work bearing upon the subject has recently been published by Professor O. Reynolds, who has investigated the flow of water in tubes as dependent upon the velocity of motion and upon the size of the bore. The laws of motion in capillary tubes, discovered experimentally by Poiseuille, are in complete harmony with theory. The resistance varies as the velocity, and depends in a direct manner upon the constant of viscosity. But when we come to the larger pipes and higher velocities with which engineers usually have to deal, the theory which presupposes a regularly stratified motion evidently ceases to be applicable, and the problem becomes essentially identical with that of skin-friction in relation to ship-propulsion. Professor Reynolds has traced with much success the passage from the one state of things to the other, and has proved the applicability under these complicated conditions of the general laws of dynamical similarity as adapted to viscous fluids by Professor Stokes. In spite of the difficulties which beset both the theoretical and experimental treatment, we may hope to attain before long to a better understanding of a subject which is certainly second to none in scientific as well as practical interest.

As also closely connected with the mechanics of viscous fluids, I must not forget to mention an important series of experiments upon the friction of oiled surfaces, recently executed by Mr. Tower for the Institution of Mechanical Engineers. The results go far toward upsetting some ideas hitherto widely admitted. When the lubrication is adequate, the friction is found to be nearly independent of the load, and much smaller than is usually supposed, giving a coefficient as low as $\frac{1}{1000}$. When the layer of oil is well formed, the pressure between the solid surfaces is really borne by the fluid, and the work lost is spent in shearing, that is, in causing one stratum of the oil to glide over another.

In order to maintain its position, the fluid must possess a certain degree of viscosity, proportionate to the pressure; and, even when this condition is satisfied, it would appear to be necessary that the layer should be thicker on the ingoing than on the outgoing side. We may, I believe, expect from Professor Stokes a further elucidation of the processes involved. In the mean time, it is obvious that the results already obtained are of the utmost value, and fully justify the action of the institution in devoting a part of its resources to experimental work. We may hope, indeed, that the example thus wisely set may be followed by other public bodies associated with various departments of industry.

I can do little more than refer to the interesting observations of Professor Darwin, Mr. Hunt, and M. Forel on Ripplemark. The processes concerned would seem to be of a rather intricate character, and largely dependent upon fluid viscosity. It may be noted, indeed, that most of the still obscure phenomena of hydro-dynamics require for their elucidation a better comprehension of the laws of viscous motion. The subject is one which offers peculiar difficulties. In some problems in which I have lately been interested, a circulating motion presents itself of the kind which the mathematician excludes from the first when he is treating of fluids destitute altogether of viscosity. The intensity of this motion proves, however, to be independent of the coefficient of viscosity, so that it can not be correctly dismissed from consideration as a consequence of a supposition that the viscosity is infinitely small. The apparent breach of continuity can be explained, but it shows how much care is needful in dealing with the subject, and how easy it is to fall into error.

The nature of gaseous viscosity, as due to the diffusion of momentum, has been made clear by the theoretical and experimental researches of Maxwell. A flat disk moving in its own plane between two parallel solid surfaces is impeded by the necessity of shearing the intervening layers of gas, and the magnitude of the hindrance is proportional to the velocity of the motion and to the viscosity of the gas, so that under similar circumstances this effect may be taken as a measure, or rather definition, of the viscosity. From the dynamical theory of gases, to the development of which he contributed so much, Maxwell drew the startling conclusion that the viscosity of a gas should be independent of its density—that within wide limits the resistance to the moving disk should be scarcely diminished by pumping out the gas, so as to form a partial vacuum. Experiment fully confirmed this theoretical anticipation—one of the most remarkable to be found in the whole history of science, and proved that the swinging disk was retarded by the gas, as much when the barometer stood at half an inch as when it stood at thirty inches. It was obvious, of course, that the law must have a limit, that at a certain point of exhaustion the gas must begin to lose its power; and I remember discussing with Maxwell, soon after the publication of his experiments, the whereabout of the point at which the gas would cease to produce its ordinary effect. His apparatus, however, was quite unsuited for high degrees of exhaustion, and the failure of the law was first observed by Kundt and Warburg, at pressures below one millimetre of mercury. Subsequently the matter has been thoroughly examined by Crookes, who extended his observations to the highest degrees of exhaustion as measured by MacLeod's gauge. Perhaps the most remarkable results relate to hydrogen. From the atmospheric pressure of 760 millimetres down to about one half millimetre of mercury the viscosity is sensibly constant. From this point to the highest vacua, in which less than one-millionth of the original gas remains, the coefficient of viscosity drops down gradually to a small fraction of its original value. In these vacua Mr. Crookes regards the gas as having assumed a different (ultra-gaseous) condition; but we must remember that the phenomena have relation to the other circumstances of the case, especially the dimensions of the vessel, as well as to the condition of the gas.

Such an achievement as the prediction of Maxwell's law of viscosity has, of course, drawn increased attention to the dynamical theory of gases. The success which has attended the theory in the hands of Clausius, Maxwell, Boltzmann, and other mathematicians, not only in relation to viscosity, but over a large part of the entire field of our knowledge of gases, proves that some of its fundamental postulates are in harmony with the reality of Nature. At the same time, it presents serious difficulties; and we can not but feel that, while the electrical and optical properties of gases remain out of relation to the theory, no final judgment is possible. The growth of experimental knowledge may be trusted to clear up many doubtful points, and a younger generation of theorists will bring to bear improved mathematical weapons. In the mean time we may fairly congratulate ourselves on the possession of a guide which has already conducted us to a position which could hardly otherwise have been attained.

In optics attention has naturally centered upon the spectrum. The mystery attaching to the invisible rays lying beyond the red has been fathomed to an extent that, a few years ago, would have seemed almost impossible. By the use of special photographic methods Abney has mapped out the peculiarities of this region with such success that our knowledge of it begins to be comparable with that of the parts visible to the eye. Equally important work has been done by Langley, using a refined invention of his own based upon the principle of Siemens's pyrometer. This instrument measures the actual energy of the radiation, and thus expresses the effects of various parts of the spectrum upon a common scale, independent of the properties of the eye and of sensitive photographic preparations. Interesting results have also been obtained by Becquerel, whose method is founded upon a curious action of the ultra-red rays in enfeebling the light emitted by phosphorescent substances. One of the most startling of Langley's conclusions relates to the influence of the atmosphere in modifying the quality of solar light. By the comparison of observations made through varying thicknesses of air, he shows that the atmospheric absorption tells most upon the light of high refrangibility; so that, to an eye situated outside the atmosphere, the sun would present a decidedly bluish tint. It would be interesting to compare the experimental numbers with the law of scattering of light by small particles given some years ago as the result of theory. The demonstration by Langley of the inadequacy of Cauchy's law of dispersion to represent the relation between refrangibility and wave-length in the lower part of the spectrum must have an important bearing upon optical theory.

The investigation of the relation of the visible and ultra-violet spectrum to various forms of matter has occupied the attention of a host of able workers, among whom none have been more successful than my colleagues at Cambridge, Professors Liveing and Dewar. The subject is too large both for the occasion and for the individual, and I must pass it by. But, as more closely related to optics proper, I can not resist recalling to your notice a beautiful application of the idea of Doppler to the discrimination of the origin of certain lines observed in the solar spectrum. If a vibrating body have a general motion of approach or recession, the waves emitted from it reach the observer with a frequency which in the first case exceeds, and in the second case falls short of, the real frequency of the vibrations themselves. The consequence is that, if a glowing gas be in motion in the line of sight, the spectral lines are thereby displaced from the position that they would occupy were the gas at rest—a principle which, in the hands of Huggins and others, has led to a determination of the motion of certain fixed stars relatively to the solar system. But the sun is itself in rotation, and thus the position of a solar spectral line is slightly different according as the light comes from the advancing or from the retreating limb. This displacement was, I believe, first observed by Thollon; but what I desire now to draw attention to is the application of it by Cornu to determine whether a line is of solar or atmospheric origin. For this purpose a small image of the sun is thrown upon the slit of the spectroscope, and caused to vibrate two or three times a second, in such a manner that the light entering the instrument comes alternately from the advancing and retreating limbs. Under these circumstances a line due to absorption within the sun appears to tremble, as the result of slight alternately opposite displacements. But, if the seat of the absorption be in the atmosphere, it is a matter of indifference from what part of the sun the light originally proceeds, and the line maintains its position in spite of the oscillation of the image upon the slit of the spectroscope. In this way Cornu was able to make a discrimination which can only otherwise be effected by a difficult comparison of appearances under various solar altitudes.

The instrumental weapon of investigation, the spectroscope itself, has made important advances. On the theoretical side, we have for our guidance the law that the optical power in gratings is proportional to the total number of lines accurately ruled, without regard to the degree of closeness, and in prisms that it is proportional to the thickness of glass traversed. The magnificent gratings of Rowland are a new power in the hands of the spectroscopist, and as triumphs of mechanical art seem to be little short of perfection. In our own report for 1882, Mr. Mallock has described a machine, constructed by him, for ruling large diffraction gratings, similar in some respects to that of Rowland.

The great optical constant, the velocity of light, has been the subject of three distinct investigations by Cornu, Michelson, and Forbes. As may be supposed, the matter is of no ordinary difficulty, and it is therefore not surprising that the agreement should be less decided than could be wished. From their observations, which were made by a modification of Fizeau's method of the toothed wheel, Young and Forbes drew the conclusion that the velocity of light *in vacuo* varies from color to color, to such an extent that the velocity of blue light is nearly two per cent greater than that of red light. Such a variation is quite opposed to existing theoretical notions, and could only be accepted on the strongest evidence. Mr. Michelson, whose method (that of Foucault) is well suited to bring into prominence a variation of velocity with wave-length, informs me that he has recently repeated his experiments with special reference to the point in question, and has arrived at the conclusion that no variation exists comparable with that asserted by Young and Forbes. The actual velocity differs little from that found from his first series of experiments, and may be taken to be 299,800 kilometres per second.

It is remarkable how many of the playthings of our childhood give rise to questions of the deepest scientific interest. The top is or may be understood, but a complete comprehension of the kite and of the soap-bubble would carry us far beyond our present stage of knowledge. In spite of the admirable investigations of Plateau, it still remains a mystery why soapy water stands almost alone among fluids as a material for bubbles. The beautiful development of color was long ago ascribed to the interference of light, called into play by the gradual thinning of the film. In accordance with this view, the tint is determined solely by the thickness of the film, and the refractive index of the fluid. Some of the phenomena are, however, so curious as to have led excellent observers like Brewster to reject the theory of thin plates, and to assume the secretion of various kinds of coloring-matter. If the rim of a wine-glass be dipped in soapy water, and then held in a vertical position, horizontal bands soon begin to show at the top of the film, and extend themselves gradually downward. According to Brewster, these bands are not formed by the "subsidence and gradual thinning of the film," because they maintain their horizontal position when the glass is turned round its axis. The experiment is both easy and interesting; but the conclusion drawn from it can not be accepted. The fact is, that the various parts of the film can not quickly alter their thickness, and hence when the glass is rotated they rearrange themselves in order of superficial density, the thinner parts floating up over or through the thicker parts. Only thus can the tendency be satisfied for the center of gravity to assume the lowest possible position.

When the thickness of a film falls below a small fraction of the length of a wave of light, the color disappears and is replaced by an intense blackness. Professors Reinold and Rücker have recently made the remarkable observation that the whole of the black region, soon after its formation, is of uniform thickness, the passage from the black to the colored portions being exceedingly abrupt. By two independent methods they have determined the thickness of the black film to lie between seven and fourteen millionths of a millimetre; so that the thinnest films correspond to about one seventieth of a wave-length of light. The importance of these results in regard to molecular theory is too obvious to be insisted upon.

The beautiful inventions of the telephone and the phonograph, although in the main dependent upon principles long since established, have imparted a new interest to the study of acoustics. The former, apart from its uses in every-day life, has become in the hands of its inventor, Graham Bell, and of Hughes, an instrument of first-class scientific importance. The theory of its action is still in some respects obscure, as is shown by the comparative failure of the many attempts to improve it. In connection with some explanations that have been offered, we do well to remember that molecular changes in solid masses are inaudible in themselves, and can only be manifested to our ears by the generation of a to-and-fro motion of the external surface extending over a sensible area. If the surface of a solid remains undisturbed, our ears can tell us nothing of what goes on in the interior.

In theoretical acoustics progress has been steadily maintained, and many phenomena, which were obscure twenty or thirty years ago, have since received adequate explanation. If some important practical questions remain unsolved, one reason is, that they have not yet been definitely stated. Almost everything in connection with the ordinary use of our senses presents peculiar difficulties to scientific investigation. Some kinds of information with regard to their surroundings are of such paramount importance to successive generations of living beings that they have learned to interpret indications which, from a physical point of view, are of the slenderest character. Every day we are in the habit of recognizing, without much difficulty, the quarter from which a sound proceeds, but by what steps we attain that end has not yet been satisfactorily explained. It has been proved that when proper precautions are taken we are unable to distinguish whether a pure tone (as from a vibrating tuning-fork held over a suitable resonator) comes to us from in front or from behind. This is what might have been expected from an *a priori* point of view ; but what would have been expected is that with almost any other sort of sound, from a clap of the hands to the clearest vowel-sound, the discrimination is not only possible but easy and instinctive. In these cases it does not appear how the possession of two ears helps us, though there is some evidence that it does ; and, even when sounds come to us from the right or left, the explanation of the ready discrimination which is then possible with pure tones is not so easy as might at first appear. We should be inclined to think that the sound was heard much more loudly with the ear that is turned toward than with the ear that is turned from it, and that in this way the direction was recognized. But, if we try the experiment, we find that, at any rate with notes near the middle of the musical scale, the difference of loudness is by no means so very great. The wave-lengths of such notes are long enough in relation to the dimensions of the head to forbid the formation of anything like a sound shadow in which the averted ear might be sheltered.

In concluding this imperfect survey of recent progress in physics, I must warn you emphatically that much of great importance has been passed over altogether. I should have liked to speak to you of those far-reaching speculations, especially associated with the name of Maxwell, in which light is regarded as a disturbance in an electro-magnetic medium. Indeed, at one time, I had thought of taking the scientific work of Maxwell as the principal theme of this address. But, like most men of genius, Maxwell delighted in questions too obscure and difficult for hasty treatment, and thus much of his work could hardly be considered upon such an occasion as the present. His biography has recently been published, and should be read by all who are interested in science and in scientific men. His many-sided character, the quaintness of his humor, the penetration of his intellect, his simple but deep religious feeling, the affection between son and father, the devotion of husband and wife, all combine to form a rare and fascinating picture. To estimate rightly his influence upon the present state of science, we must regard not only the work that he executed himself, important as that was, but also the ideas and the spirit which he communicated to others. Speaking for myself as one who in a special sense entered into his labors, I should find it difficult to express adequately my feeling of obligation. The impress of his thoughts may be recognized in much of the best work of the present time. As a teacher and examiner he was well acquainted with the almost universal tendency of uninstructed minds to elevate phrases above things: to refer, for example, to the principle of the conservation of energy for an explanation of the persistent rotation of a fly-wheel, almost in the style of the doctor in "Le Malade Imaginaire," who explains the fact that opium sends you to sleep by its soporific virtue. Maxwell's endeavor was always to keep the facts in the foreground, and to his influence, in conjunction with that of Thomson and Helmholtz, is largely due that elimination of unnecessary hypothesis which is one of the distinguishing characteristics of the science of the present day.

In speaking unfavorably of superfluous hypothesis, let me not be misunderstood. Science is nothing without generalizations. Detached and ill-assorted facts are only raw material, and, in the absence of a theoretical solvent, have but little nutritive value. At the present time and in some departments, the accumulation of material is so rapid that there is danger of indigestion. By a fiction as remarkable as any to be found in law, what has once been published, even though it be in the Russian language, is usually spoken of as "known," and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory. In this matter we are greatly dependent upon annual reports and abstracts, issued principally in Germany, without which the search for the discoveries of a little-known author would be well-nigh hopeless. Much useful work has been done in this direction in connection with our Association. Such critical reports as those upon hydro-dynamics, upon tides, and upon spectroscopy, guide the investigator to the points most requiring attention, and in discussing past achievements contribute in no small degree to future progress. But, though good work has been done, much yet remains to do.

If, as is sometimes supposed, science consisted in nothing but the laborious accumulation of facts, it would soon come to a stand-still, crushed, as it were, under its own weight. The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence facilitates the retention of the remainder in an available form. Those who are acquainted with the writings of the older electricians will understand my meaning when I instance the discovery of Ohm's law as a step by which the science was rendered easier to understand and to remember. Two processes are thus at work side by side, the reception of new material and the digestion and assimilation of the old; and, as both are essential, we may spare ourselves the discussion of their relative importance. One remark, however, should be made.

The work which deserves, but I am afraid does not always receive, the most credit is that in which discovery and explanation go hand in hand, in which not only are new facts presented, but their relation to old ones is pointed out.

In making one's self acquainted with what has been done in any subject, it is good policy to consult first the writers of highest general reputation. Although in scientific matters we should aim at independent judgment, and not rely too much upon authority, it remains true that a good deal must often be taken upon trust. Occasionally an observation is so simple and easily repeated that it scarcely matters from whom it proceeds; but as a rule it can hardly carry full weight when put forward by a novice whose care and judgment there has been opportunity of testing, and whose irresponsibility may tempt him to "take shots," as it is called. Those who have had experience in accurate work know how easy it would be to save time and trouble by omitting precautions and passing over discrepancies, and yet, even without dishonest intention, to convey the impression of conscientious attention to details. Although the most careful and experienced can not hope to escape occasional mistakes, the effective value of this kind of work depends much upon the reputation of the individual responsible for it.

In estimating the present position and prospects of experimental science, there is good ground for encouragement. The multiplication of laboratories gives to the younger generation opportunities such as have never existed before, and which excite the envy of those who have had to learn in middle life much that now forms part of an undergraduate course. As to the management of such institutions there is room for a healthy difference of opinion. For many kinds of original work, especially in connection with accurate measurement, there is need of expensive apparatus; and it is often difficult to persuade a student to do his best with imperfect appliances when he knows that by other means a better result could be attained with greater facility. Nevertheless, it seems to me important to discourage too great reliance upon the instrument-maker. Much of the best original work has been done with the homeliest appliances; and the endeavor to turn to the best account the means that may be at hand develops ingenuity and resource more than the most elaborate determinations with ready-made instruments. There is danger otherwise that the experimental education of a plodding student should be too mechanical and artificial, so that he is puzzled by small changes of apparatus much as many school-boys are puzzled by a transposition of the letters in a diagram of Euclid.

From the general spread of a more scientific education, we are warranted in expecting important results. Just as there are some brilliant literary men with an inability, or at least a distaste practically amounting to inability, for scientific ideas, so there are a few with scientific tastes whose imaginations are never touched by merely literary studies. To save these from intellectual stagnation during several important years of their lives is something gained; but the thorough-going advocates of scientific education aim at much more. To them it appears strange, and almost monstrous, that the dead languages should hold the place they do in general education; and it can hardly be denied that their supremacy is the result of routine rather than of argument. I do not, myself, take up the extreme position. I doubt whether an exclusively scientific training would be satisfactory; and where there are plenty of time and a literary aptitude I can believe that Latin and Greek may make a good foundation. But it is useless to discuss the question upon the supposition that the majority of boys attain either to a knowledge of the languages or to an appreciation of the writings of the ancient authors. The contrary is notoriously the truth; and the defenders of the existing system usually take their stand upon the excellence of its discipline. From this point of view there is something to be said. The laziest boy must exert himself a little in puzzling out a sentence with grammar and dictionary, while instruction and supervision are easy to organize and not too costly. But, when the case is stated plainly, few will agree that we can afford so entirely to disregard results. In after-life the intellectual energies are usually engrossed with business, and no further opportunity is found for attacking the difficulties which block the gateways of knowledge. Mathematics, especially, if not learned young, are likely to remain unlearned. I will not further insist upon the educational importance of mathematics and science, because with respect to them I shall probably be supposed to be prejudiced. But of modern languages I am ignorant enough to give value to my advocacy. I believe that French and German, if properly taught, which I admit they rarely are at present, would go far to replace Latin and Greek from a disciplinary point of view, while the actual value of the acquisition would, in the majority of cases, be incomparably greater. In half the time usually devoted, without success, to the classical languages, most boys could acquire a really serviceable knowledge of French and German. History and the serious study of English literature, now shamefully neglected, would also find a place in such a scheme.

There is one objection often felt to a modernized education, as to which a word may not be without use. Many excellent people are afraid of science as tending toward materialism. That such apprehension should exist is not surprising, for unfortunately there are writers, speaking in the name of science, who have set themselves to foster it. It is true that among scientific men, as in other classes, crude views are to be met with as to the deeper things of Nature; but that the life-long beliefs of Newton, of Faraday, and of Maxwell, are inconsistent with the scientific habit of mind, is surely a proposition which I need not pause to refute. It would be easy, however, to lay too much stress upon the opinions of even such distinguished workers as these. Men who devote their lives to investigation cultivate a love of truth for its own sake, and endeavor instinctively to clear up, and not, as is too often the object in business and politics, to obscure a difficult question. So far the opinion of a scientific worker may have a special value ; but I do not think that he has a claim, superior to that of other educated men, to assume the attitude of a prophet. In his heart he knows that underneath the theories that he constructs there lie contradictions which he can not reconcile. The higher mysteries of being, if penetrable at all by human intellect, require other weapons than those of calculation and experiment.

Without encroaching upon grounds appertaining to the theologian and the philosopher, the domain of natural science is surely broad enough to satisfy the wildest ambition of its devotees. In other departments of human life and interest, true progress is rather an article of faith than a rational belief ; but in science a retrograde movement is, from the nature of the case, almost impossible. Increasing knowledge brings with it increasing power, and, great as are the triumphs of the present century, we may well believe that they are but a foretaste of what discovery and invention have yet in store for mankind. Encouraged by the thought that our labors can not be thrown away, let us redouble our efforts in the noble struggle. In the Old World and in the New, recruits must be enlisted to fill the place of those whose work is done. Happy should I be if, through this visit of the Association, or by any words of mine, a larger measure of the youthful activity of the West could be drawn into this service. The work may be hard, and the discipline severe ; but the interest never fails, and great is the privilege of achievement.

MAN'S RIGHT OVER ANIMALS.

By CHARLES RICHET.

THERE is no such impassable gap between man and the animals that they can not be considered brothers in creation, and therefore liable to certain reciprocal obligations. As it is our duty to be just and sympathetic toward men, it is equally our duty not to be wicked or cruel toward animals. Whoever believes that he has a right to cause death or suffering to innocent beasts for his own pleasure is unworthy to be called a man. This precept is, however, limited by the consideration of what is useful to us. A dangerous or noxious animal may be destroyed without pity ; for, whatever may be our duties toward the animal, our duties toward man are greater. Thus, no one would think of having any mercy on the phylloxera, the pest of the grape-vine, but all would consider it a pious duty to destroy that baleful insect; and it is right to use every effort to hunt out the tigers and serpents of India. All the world is of one mind on these points.

Besides these maleficent animals there are useful ones, which serve us food, or on which we call for daily help. It would be absurd to prevent horses from drawing carriages, or oxen from being yoked to plows. The suppression of animal food, which is almost necessary to our existence, is not a subject for serious consideration. But if man has the right to slay an animal to live upon its flesh, it does not follow that he has the right to make it suffer before killing it. Legitimate as it may seem to kill a sheep to make food of it, it would be cruel to take the animal and expose him to torture for the vain pleasure of watching his contortions and observing his pain. It is, however, this very pain and just such contortions that physicists who make vivisections study with curiosity; and this leads us to the consideration of the question, Has man the right to make living beings suffer for purposes of utility or information?

We remark, first, that if vivisection is to be proscribed, it will be impossible to draw the line at any animal. If morality prohibits us from experimenting on the dog, we must, by the same rule, respect the cat, the rabbit, the fowl, the turtle, and the frog. If we prohibit the use of the frog, how can we permit the use of the snail, the oyster, and the medusa? In a little while we come to those beings the animal nature of which is in dispute. If we are forbiden to send an electric current through the body of a medusa, I do not see what right we have to electrify bacteria. Finally, it might be made to appear a culpable act to put an axe into an oak, or to electrify a sensitive-plant, since in either case we disorganize a living being, and possibly produce suffering. Thus easily is the reasoning of the anti-vivisectionists reduced to absurdity.

The anti-vivisectionists, however, direct their opposition against the infliction of pain; and that, they say, is acute in proportion as the animal is intelligent. The animals nearest in order to man are the ones which it is most important to spare from suffering, and there are gradations in the wrong. It is very wrong to make a dog suffer, but the matter is less a crime when it comes to a rabbit. A frog and a crawfish are entitled to still less compassion, and, in the case of the medusæ, bacteria, and plants, whose sensibility is less developed, the act is only half reprehensible. This argument yields the point that we have a right to experiment upon animals which do not feel suffering, or only feel it a little. Let us leave out the question of the inferior animals, and go straight to the strongest argument that can be brought forward, that which turns upon the martyrdom of the dog. Let us take the question, as they say, by the horns, and see if the physiologists have the right to make a dog suffer.

I love dogs for themselves; I have as much compassion as any one can have for them when they are suffering; I know by experience that their friendship is a precious resource in solitude; but, however, much I may feel for dogs, I should never hesitate to sacrifice the dearest pet among them all for the existence of a human being, even were the man unknown to me, or the lowest of savages. Hesitation as between a dog and a man is not permissible. We owe aid and love to the beings who are nearest to us, in the degree that they are nearer, to a Frenchman more than to a Chinese, to a man more than to an animal. We are all of the great human family, to all the individuals of which we owe justice and assistance, while we owe to animals pity and protection only when they involve no harm to our human brethren.

The principal object of science, and particularly of physiological science, is to be useful to men. Knowledge of the laws of Nature alone can help us to assuage the miseries of our existence. Every step of progress in our knowledge leads in the end to a forward step in our career. Even though we may not immediately comprehend the practical utility of a particular discovery, it will eventually bear a sure fruit. The innumerable and mysterious facts of the medium in which we live are subject to fixed laws that are only imperfectly known. All our efforts should tend to elucidate these laws; and science—that is, the investigation of the grand laws of Nature—seems to be one of the principal functions of human energy. A very high value should, therefore, be set upon everything that aids the progress of science.

It is an erroneous view of science to expect that it shall at once give a result useful, palpable, and precise, or an instantaneous practical application. Science has nothing to do with utility; or, rather, the true utilitarians are those whose hopes are in future science. They are forced to respect the science of to-day, even when it appears useless, because it is bringing us nearer to the science of to-morrow, which alone can effect some great alleviation to human suffering.

Who could have conceived, when Galvani announced that, on touching the foot of a frog with copper and zinc, he provoked contractions of its muscles, that this little fact would lead, by a remarkable series of discoveries, to the invention of the galvanic battery, electric telegraphy, and dynamic electricity? If Galvani had not observed the feet of frogs, the electric telegraph would never have existed, nor the electric light, nor any of those marvelous machines which constitute one of the greatest series of forces man now has at his disposal. Yet, at the moment Galvani was making his discovery, would we not, at least apparently, have had a right to condemn his sterile and bloody experiments? What benefit could men gain from a massacre of frogs strung along a balcony-rail?

Every new discovery, however trivial it may seem at first, is big with discoveries to come. One truth is the germ of innumerable others. Thus we have no right to restrict the domain of science, and, for the sake of saving some unfortunate being a few passing sufferings, to smother in its cradle all the hope of the future.

The science of life—that is, physiology—can not progress without vivisection. To interdict this practice would be to slay that study. The anatomical examination of the organs teaches us nothing, or hardly anything, respecting their functions. How could we understand the circulation of the blood, if our only resource was the anatomical study of the heart, arteries, and veins? What idea would a description of the brain give of the functions of the brain? We might see the strange forms and complicated structure of the cerebral apparatus; but the examination of these forms would be of no help toward gaining an acquaintance with their offices. The work of physiology is founded entirely on experiment, and the required experiments can be made only upon living beings. Sometimes these beings are plants, but this is only a part of physiology. Animal physiology requires animals. The observation of dead bodies is not useful in teaching the laws of life. Suppose a skillful artisan, to whom we give a watch to examine. In vain will he look through his lens at the springs, the wheels, the cogs, the jewels, and the whole machinery, so long as the watch is not wound up; for he can not find out from this whether it will go or how it goes. To learn the movement of a watch, it must be seen in motion. The same rule is in force for the physiologist. A dead organ tells him nothing; he must see it living.

There are, then, but two alternatives—either to stop physiology in its progressive course, to shut our books, and give up the study of the vital functions, or to continue the practice of experimental researches and vivisections, as Galen, Harvey, Haller, Magendie, and Claude Bernard did. If we think physiology is not a science, or imagine it is useless to man, all right. Let us be contented to observe the stars, and resign ourselves to ignorance of the conditions of our existence. But if we want to sound the mysteries of life, to penetrate to the causes and mechanism of the forces that rule us, then we should continue our efforts without allowing ourselves to be discouraged by unjust attacks. We may be sure of an abundant harvest; and every day, at the price of a few rabbits, frogs, or dogs, will give us some important discovery. Thus, even if physiology (with which we include vivisection, for they are one) does not immediately give practical contributions to the relief of the human race, it is nevertheless a good thing, for the immediate result of a discovery is often nothing, while the discovery may perhaps bring about wonderful consequences in the future.

The favorite argument of the enemies of vivisection is, that physiology is of no use in medicine. "Never," they say, "has a vivisection or a physiological discovery gained by experiment been of any aid to therapeutics. Chance, not physiology, has made us acquainted with the medical properties of cinchona, mercury, opium, and chloroform. The great physiological discoveries, though interesting as curiosities, have not been for our good. What has come from the knowledge of the circulation of the blood? Are we any more able to cure affections of the spinal marrow because we know now, what we did not know a hundred years ago, that there are motor cords and sensitive cords in it? If mortality is less now than formerly, it is not in consequence of the progress of medicine, but of general hygiene. Now, as much as three hundred years ago, doctors are impotent to cure diseases, and all the improvements in modern medicine are due to the attentive observation of the sick, not to experiments on animals." This reasoning finds credit with the ignorant, for it artfully mingles a little truth with much error. The physician is, alas! too often powerless to contend against the ills that are raging around us. But, really, we can not expect physiology to cure incurable diseases and make men immortal; its mission is to discover the truth, and it is for the physician to apply the lessons of the new truth to the treatment of diseases. Who can say seriously that modern medicine, enlightened by the great physiological discoveries of this and former centuries, is not superior to the medicine of the middle ages? The circulation of the blood was discovered by vivisection. Can we form a practical conception of a doctor who does not believe in the circulation of the blood? Is there a man among the members of the Society for the Protection of Animals that would commit himself to the care of such a doctor? To be consistent, they should banish from therapeutics all of it that is the result of experiment, and accept only that which is due to chance or empiricism; there would be very little left! We should not have galvanic electricity, for all our knowledge of this is due to the experiments of vivisectors. We should possess, in the way of medicines, only a few simples, and should have to employ them empirically, without being permitted to obtain a clear idea of their dangers or their advantages. We should not have chloral, or injections of morphine, or bromide of potassium. We should be reduced to prescribe decoctions of cinchona, or that old theriac compounded of nearly two hundred plants of different properties.

It may be that the number of those whom modern medicine, relying upon experiment, has cured, is not large; but certainly the number whom it has relieved is immense. If it can not cure disease, it can at least prevent pain. Why, then, should so much account be taken of a few pains of animals in the face of the thousands of men we have saved from suffering? We should not be indignant that a dog may be sacrificed every day in the thirty physiological laboratories that are scattered over the whole world; for the thirty dogs that suffer bear no sort of proportion to the thousands of cases of pain through the whole civilized world which medicine abbreviates or diminishes in a single day. If the sick thus relieved could give their testimony and knew how to do it, they would confound the sentimental objections of the anti-vivisectionists, and would declare that their own sufferings deserve a higher consideration than the sufferings of a few animals.

The physiologist in his experiments is inspired by a humane sentiment—by love, not only for the present, but for future generations as well, of mankind, for his purpose is to discover some of the truths that may contribute to the relief of man. The immediate consequence, the practical end, may often escape him, but he is not concerned with them; for he long ago in his own mind identified science with the love of man. He has acquired a conviction that science and the love of his fellows are the same thing, and that every scientific conquest is a step in the way of social progress. I do not believe that any experimenter would say, on giving curare to a rabbit, or in cutting the marrow of a dog, or in poisoning a frog, "This experiment is destined to help cure or relieve some man's disease." He would not think of that, but would say, "I am going to dissipate an obscurity, to seek out a new fact"; and this scientific curiosity, the only thought that animates him, can be explained in no other way than as a consequence of the exalted ideal he has conceived of science.

This is why we pass our days in nauseous dissecting-rooms, surrounded by groaning beings, in the midst of blood and suffering, bent over palpitating viscera. We love science for itself, for the grand results it is destined to give, and we surrender ourselves with passion to the disinterested investigation of the truth that is hidden in things, convinced that this truth will in time become the salvation and hope of our brethren.

No parity can be established between the results obtained and the price they cost. A few sufferings of animals while so many other animals are suffering are as nothing in comparison with the results of a scientific discovery. Must we, when a great result is to be secured, charge up an account of the suffering or the death of a small number of individuals? We may suppose, for instance, that the magnificent work of constructing the canal across the Isthmus of Panama will cost, in consequence of the necessity of extensive labors in an unhealthy country, the lives of several hundred or even of a few thousand coolies. Must we, then, give up making the canal? By it we would shorten the route of many thousand ships. Most certainly the facility given to commerce, the greater wealth and prosperity that will be conferred on all mankind, will compensate for the death and sickness of these poor, obscure laborers. It is the same in war. If a general in the course of a battle believes it necessary to carry a redoubt, he will not hesitate to give the signal for the assault, even if he knows that the struggle will cost the lives of a thousand men. He will sacrifice a few squads, for the safety of the whole army, without any hesitation. By the same rule, a people has a right to make war in defense of its independence, although every war is accompanied by thousands of deaths and woes. The case is controlled by the consideration of a superior interest. The freedom of a people is at stake, and the interests of a whole people at times exact the sacrifice of a few citizens.

The struggle of the scientific investigator against natural forces in some degree resembles the struggle of a people for its liberty. Material laws bind us on all sides, and to secure deliverance from them it is necessary to become acquainted with them. It is our liberty as against the things it is necessary to conquer ; and it is not a dear bargain to buy this at the price of a few dogs and a few skinned frogs.

The sentimental spirits who are so much interested in the lot of our victims seem to believe that there is no more important occupation for them. We must undeceive them. There are more pains than joys among the men on this little terrestrial globe. Instead of busying themselves to prevent the researches which are being privately carried on in a few laboratories, let these charitable people make an effort to put down the slave-trade, of which negroes are the victims by thousands. Or let them endeavor to relieve the misery which prevails everywhere from Greenland to the land of the Hottentots. Let them try to suppress the terrible scourge of war, which has made a hundred thousand times more human victims than all the frogs, rabbits, and dogs that have been sacrificed by all the physiologists in the world. There is a task worthy of their activity.

We are apt, when we speak of pains and martyrdom, to exaggerate the sufferings of animals. There is no pain unless there is consciousness and attention to the pain. The more intelligent a being is, the more it can suffer. Unintelligent animals are incapable of feeling in its fullness the sensation we call pain. We can not form an idea of what a frog feels when we cut one of its nerves ; probably we never shall know what it feels ; but it appears to me that the pain it feels then is very vague and very confused. Compared to man, whose intelligence is so clear, the inferior animals are like automatons : most of their acts are half involuntary. They are not deliberate acts, maturely reflected out, but irresistible impulsions of which the actors have imperfect consciousness. These animals live in a kind of dream or half consciousness that excludes terrible pain. Their nerves are less excitable, and their brain is less susceptible of that clear perception of self without which pain can hardly be.

It is not without reason that we feel little remorse in martyrizing an animal of low degree in the series of beings. As we descend from man to the plant, intelligence diminishes, consciousness becomes more and more confused, and therefore the sensibility to pain is more and more obtuse. This is only a personal opinion, and it would be impossible to give a rigorous proof of it ; but every day's observation seems to confirm its reality.

No one has a right to believe that a physiologist takes any pleasure in making animals suffer. For my part, I always feel a painful sensation whenever it is necessary to fix a dog to the experimenting-table. All physiologists, whenever it is possible, try to anæsthetize their victim with chloral, morphine, chloroform, or ether. When the anæsthetization is completed, the animal does not suffer, and all the experiments afterward made upon it are without cruelty. It is very rarely necessary to experiment upon an animal that has not been treated with an anæsthetic; and even in these cases it is possible, by various processes, to make the pain much less acute. I always endeavor to ameliorate the pains of the animals I subject to experiments. Yes, I have caused rabbits, frogs, and dogs to suffer; but I believe that never, since I reached a man's age, have I taken pleasure in inflicting suffering upon a living being. For every animal, even the lowest, I feel something analogous to pity and sympathy; and I have a right to say this, for there is no contradiction between such sympathy and physiological experiment.*

Instead of developing cruelty, the practice of physiology should rather tend to increase in us the feeling of humanity and pity. The physician who has closely observed human suffering, instead of being hardened to it, becomes more compassionate. So the physiologists, who are acquainted with pain, are full of pity for suffering beings, and I do not hesitate to say that not one of them would be guilty of brutality toward an animal. It is true that they immolate dogs and rabbits, but that is for a superior interest; and in their very experiments they prove their clemency by trying to save their victims from useless sufferings.

In truth, if we divest ourselves of all vain sentimentality, we shall arrive at the conclusion that innumerable and extreme sufferings are already imposed by Nature upon living beings. Over the whole surface of the earth, in Borneo as in France, in the Sahara as in Lapland, men and animals are suffering. In the depths of all the seas, in the currents of all the rivers, on all the shores of all the oceans, in all the forests, and in all the plains, suffering and pain exist. Our object is to bring in some mitigation for all these evils, and it can not be accomplished except by the aid of science, through becoming acquainted with the laws of life. What then, compared to such a grand result, are the confused groans of the unfortunate dogs we immolate from time to time? Indeed, we have a right to sacrifice these rare and innocent victims, for at as small a price as that we can become masters of living nature, and may be able to penetrate the laws of life, and to relieve the unfortunate of our kind.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

* It is with great reluctance that we perform vivisections in public lectures for instruction. When the question is one of scientific research, the act must be performed resolutely and without regard to the pain; but, whenever the purpose is to demonstrate before any audience a known phenomenon, the greatest reserve should be exercised in the employment of means that are cruel.

FETICHISM OF THE BANTU NEGROES.

By MAX BUCHNER.

THE African negroes, like all primitive peoples, are great children. Too much should, therefore, not be made of their mental acts. That wonderful system of mystic conceptions which closet theologians believe they can discover among them can not stand the test of serious, unprejudiced examination. More time and sharper acumen than many writers on the subject possess are needed for the formation of a valid idea of the religious conceptions of these people. A five-year-old girl playing with her doll is a better medium for studying primitive mythologies than the heaviest volumes of anthropologists and ethnographists.

I believe that much that is said about fetich-worship rests on no solid foundation; neither a kind of worship nor any serious service is addressed to the harmless toy we call a fetich, but only a mysterious good or evil spirit is fancied to dwell within it.

A negro, as is his habit, is sitting and thinking about nothing. Casually he casts his eye upon a knotted limb of strange growth that may bear some indistinct resemblance to a human face. Amused at it, he takes his knife and makes an effort to help out Nature by scratching the nose, mouth, and eyes into plainer prominence. At last the thing appears so curious that he concludes he will take it home and set it up before his hut. It becomes his "fetich," and grins to-day pleasantly, to-morrow with a cross air, at him. To heighten the effect, he paints it red around the eyes, or adorns it with bright ornaments. In some such way as this, I believe, we may explain the origin of the first images of the gods, new illustrations of which we may still observe to be brought before us from time to time. I do not regard the process as a religious one, but rather as an instance of the development of the first idea of art.

It is not, however, the pleasure of contemplating new forms that secures their preservation and the attention that is afterward given them. In the feeling of the need of some protection against evil the objects become associated with the events that happen to their owner, and endowed with a power to influence their course. Then they are copied, and a fixed type is established; but the utilization of them for religious purposes is, in my opinion, a secondary matter. Instead of fetiches or idols, such objects might be called amulets or medicines. In the course of time great numbers of religious medicinal structures have been formed, all of them originating in some such way as we have outlined, representatives of which may be found everywhere, most curious figures, in the towns, in the fields, at the cross-roads, and in the most out-of-the way and lonesome places. If we ask what they are for, we shall generally receive some indefinite answer. They may be "for a dead man," "to kill witches," "battle-charms," or "to keep thieves away." Intelligent negroes will sometimes laugh in making such communications, as if they were ashamed at being caught indulging in silly conceits.

Without going into an elaborate account of African fetiches, it will be enough for our purpose to give a few examples that may illustrate the way some of them have been developed and the purposes to which they are applied. The first figure represents a specimen of the most primitive character that may be very readily imagined to have originated in the way we have indicated. Between two vine-stocks that have been intertwined in double spirals around slender stems is

Fig. 1.

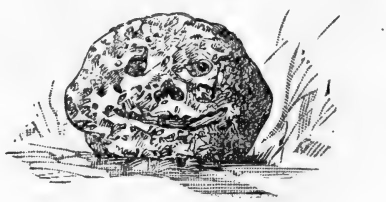

Fig. 2.

standing, firmly set in the ground, a knotty stump that has been helped out into the caricature of a face. I found the original of this in a Luba village. Of a similar grade is Fig. 2, a round mass from a termite's nest, about twice the size of a man's head, the porous fungoid substance of which has been set off with carved suggestions of mouth, nose, and eyes. This is a very common ornament of the corners of the manioc-fields. A fetich of a more complicated character is shown in Fig. 3—a little straw hut, about twenty inches high, shaped so as to suggest some fabulous beast. The original, which belonged to an Ovambo village, looked more formidable than the picture. Some dirt was heaped up under the middle of the tent, in which snail-shells, bones, and roots were found when it was stirred with a stick, and which was probably designed to represent the entrails of the creature. I could not get any explanation of the design represented in Fig. 4. We found it one day in a wood in Minungo-land—a cross-road large enough for a ten-pin alley, beginning near the regular path, with a kind of a gallows of slender sticks, and ending at a miniature hut about a yard high. Nothing was found in the hut besides an empty pot; but two interlinked straw rings were hanging from the cross-beam of the gallows. When I asked my interpreter Pedro what it was for, he replied that it

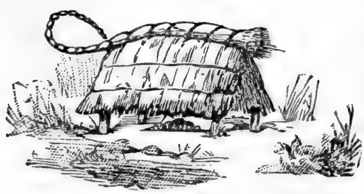

Fig. 3.

was to catch men. I did not press him with any more questions, for I knew he would answer me with the first lie he could think of.

Numerous grave-marks are characteristic of all the roads and paths of Angola; they are, according to the degree of civilization and the

FIG. 4.

social importance of the deceased, either large earthern catafalques with towers at the corners, such as are erected by the Africo-Portuguese, simple long mounds of the form everywhere used, or a little stone-heap. Graves of the first two classes are generally sheltered by a hut or roof. Graves of the last kind, which are very often the graves of porters that have died on the road, are frequently found fresh and adorned with the staff, the belt, the provision-bag, the water-gourd, or the cooking-pot of the dead man. The best finished catafalques of earth are whitewashed and painted with pretty colored arabesques and flowers. Vessels in which food has been brought to the deceased at various times may be found scattered around the grave, together with burned clay figures of the most curious character.

Sometimes the graves contain nothing but the hair and nails of the persons to whom they are erected; for the man may have died on a journey, and have been buried among strangers. But, in order that a place may be provided near his home where his spirit may linger, and enjoy the food and drink that are regularly brought to it, one of his friends will cut off some of his hair and nails, and present them to the family to be formally buried as a symbol of the whole body, which it is not convenient to remove. The little relics are then mourned over and buried just as if they were the body itself, which is, however, moldering far away. Such a monument was the pile of wood which I found near Malansh, a copy of my drawing of which is given in Fig. 5. It may, however, be a hunter's medicine, for that was one among the explanations that were given me of its purpose. Four rough-hewed tree-trunks served as posts to hold up the structure of logs and limbs and straw. In front of the structure was a carved idol, on both sides of which stood limbs of trees garnished with skulls and antelopes' jaws, while near the idol lay a pot containing pieces of meat in a brown sauce. The corner posts and the idol were painted with white and red spots.

Besides these fixed amulets are also to be reckoned in the category of art-works smaller toys that are worn as ornaments. Among these are some kinds to which superstition has attributed particular powers, made of antelope-horn, snail-shells, and small turtle-shells, the hollow parts of which are filled with a magic salve, made of coal-dust and palm-oil. One of the most potent amulets is the *pemba*, a fine, white clay resembling kaolin, which is brought from some distance, and forms an article of trade. It is used much in the same manner as the holy water of the Roman Catholics, and the expression "pemba" has a similar significance with our "good-luck" or "blessing." The term to "give pemba" is used to designate the application of the moistened substance to the arm or the breast. Feeble or sickly persons or beggars, who wish to accomplish an object with a higher personage, besmear their whole faces with it. A master, hunting his runaway slaves, paints with it a white ring around his right eye, in the belief that he will thereby be able to see more sharply.

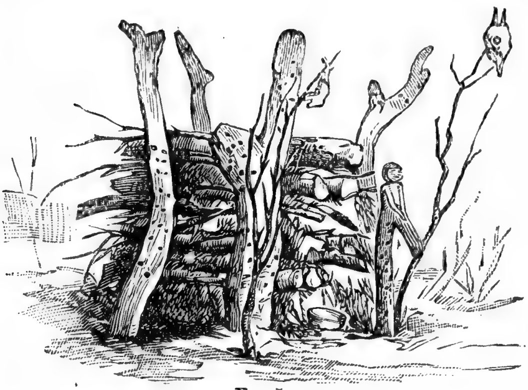

Fig. 5.

Although the negroes possess no real writing, they seem to have the beginning of it in the shape of tally-sticks and proprietary marks. Creditors and debtors are accustomed to note the number of objects of value, pieces of cloth, etc., on sticks; and traveling merchants and porters perpetuate the number of their night-camps on their walking-canes, on which important events are also emphasized by larger or differently shaped marks. If a gourd of unusual size or beauty is growing anywhere, the owner of it cuts a peculiar mark on it, by the aid of the mysterious influence attached to which he is able to keep it as his own. Some of the best designed proprietary marks we observed are represented in Fig. 6.

The musical capacity of the negroes is higher than their aptitude for imitative art. The most complicated trumpet-signals can not be given more clearly and correctly than is done by the black soldiery of Angola. The melodies of these Africans are very touching and resonant. The antiphone of a large file of porters going out in the morning was a real treat to my otherwise little appreciative ears. It usually began with a lively recitative by the best-voiced man of the company, with which the others fell in in harmonious refrain. The simple, endlessly repeated text was constantly taken up anew, and related to a fact not very interesting in itself: "We are carrying Souza's goods to Kulamushita, cloth, pearls, powder, and brass wire; Souza is rich, Souza will give us good schnapps." Refrain: "Yes, Souza will give us good schnapps." Regular songs do not appear to exist, and the airs that are sung of evenings over the camp-fires are of the same improvised character.

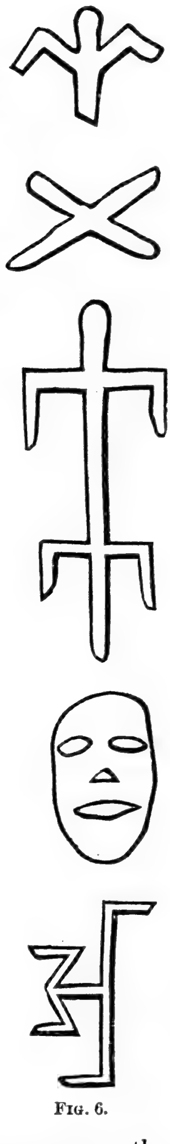

Fig. 6.

Besides his voice, the negro makes music with whatever will make a noise—two sticks, old fruit-cans, iron articles, or stones. He also has a number of musical instruments that are not to be despised, the best of which, the *maximba*, would not be unworthy to be called a clavier.

Besides music and songs, the evening circles are enlivened with stories of adventure and occasional animal fables, which I am not able to recall. One story, which was told me by a mulatto woman in Malansh, was evidently an adaptation of a Portuguese nurse's story. In these tales the interposition of an interval between two events is expressed in a very curious manner, as, "And now he waited a month, r-r-r-r-r . . . and he waited another month, r-r-r-r-r," each trilling with the tongue, which generally lasted about half a minute, answering for the designated interval.

There is not much to be said about the scientific conceptions of the negroes. Most of our clews to their character are derived from their verbal expressions. Among the heavenly bodies they distinguish the sun and moon, the larger planets, and the fixed stars, the latter only in general, without taking consideration of individual stars or particular groups. The larger planets are called wives of the moon, whence it proceeds that chaste Luna is regarded as a man. Little use is made of the rising and setting of the sun to express direction, which is usually described as "up" or "down," according to the course of the streams.

Of minerals, the natives distinguish between stone and earth, and the latter as dry (sand) and moist (mud). Of earths, they speak of red earth, or laterite, and white or gray earth, alluvium. Bog-iron ore, which is abundant, is "the great stone." Among the metals, copper is known; and the word signifying copper is in some of the dialects applied to the moon. Their vocabulary is rich in names of animals and plants. Not one of the plants growing in the plains is without its name, but the flora of the ravines is less well provided for. Separate class-names are, however, given to the broad-leaved evergreen vegetation of the ravines and the vegetation of the plains, as a whole. Swamps are called "bad brooks." Carnivorous animals, the lion, the leopard, and the hyena, and night-birds, are regarded as evil spirits or magicians. In the stories, the lion is always spoken of as "Mr. Lion." Three color-names are known, to distinguish between white or light colors, blue or dark ones, and red, green being considered a variety of red. Notwithstanding this poverty of names, their conceptions of colors appear to be as diversified and distinct as those of other men. They have no words for sweet and sour, but whatever tastes to suit them is "piquant." They are very ingenious in the invention of nicknames and descriptive terms, which have generally some direct reference to peculiarities in the appearance, history, or character of the persons to whom they are applied. Some of the instances of their coinages in this category, which I met in my travels, were comical.—*Translated for the Popular Science Monthly from Das Ausland.*

FURTHER REMARKS ON THE GREEK QUESTION.

By JOSIAH PARSONS COOKE.

IN a former article published in this "Monthly"* I endeavored to make prominent the essential difference between a system of education based on scientific culture and the generally prevailing system which is based on linguistic training. I maintained that there is not only a difference of subject-matter, but a difference of method, a difference of spirit, and a difference of aim; and I argued that, as the conditions of success under the two modes of culture are so unlike, there was no danger, even with the amplest freedom, that the study of the physical sciences would supplant or seriously interfere with linguistic studies. But, although the drift of my argument was plain, the passage referred to has been quoted in order to show that not only Greek, but also all linguistic study, would be neglected by the students of natural science as soon as it ceased to be useful in their profession; and my attempt to point out a basis of agreement and co-operation has been made the occasion of reiterating the extreme doctrine that there can be no liberal education not based on the study of language. It has been thus assumed that scientific culture can not supply such a basis, and in this whole discussion the value of the study of Nature in education, except in so far as this study may yield a fund of useful knowledge, has been entirely ignored by the advocates of the old system. Not only has there been no recognition of the value of the study

* November, 1883.

of material forms and physical phenomena as a mode of liberal culture, but it has been assumed throughout that—to use the now familiar form of words—"no sense for conduct" and "no sense for beauty" can be acquired except through that special type of linguistic training that has so long limited elementary education. Those who demand a place for science-culture certainly have not shown the same contemptuous spirit; and I venture to suggest that, if classical students were as familiar with the methods of natural science as are the students of Nature with philological and archæological study, they would be more charitable to those who differ with them on this subject.

There are, of course, two distinct elements in a liberal education: the one the acquisition of useful knowledge, the other a training or culture of the intellectual faculties. The first should be made as broad as possible, the second in the present state of knowledge must unfortunately be greatly restricted. While in the passage referred to I have claimed that, in a system of education based upon science, languages should be studied simply as tools, Mr. Matthew Arnold, in a lecture which he has recently repeatedly delivered in this country, and whose text was the phrases I have already quoted, has claimed that, although scholars must use the results of science as so much literary material, they need have nothing to do with its methods. In my view, both positions are essentially sound. It has been said that the Greek departments in our colleges could do without the scientific students much better than scientific scholars could do without Greek, and this remark admits of an evident rejoinder. Certainly in this age no professional man can afford to be ignorant of the results of science, and he will constantly be led into error if he does not know something of its methods. It is perfectly well known that very few of the investigators, who have coined the scientific terms derived from the Greek, so often referred to, could read a page of Herodotus or Homer in the original; and it is equally true that Mr. Matthew Arnold, and his compeer, Lord Tennyson, who have shown such large knowledge of the results of science, could not interpret the complex relations in which the simplest phenomena of Nature are presented to the observer. The greater number of the students of Nature can only know the beauties of Greek literature as they are feebly presented in translations, and so the greater number of literary students can only know of the wonders of Nature as they are inadequately described in popular works on science. If it requires years of study to enable a student to master the meaning of a Greek sentence, can we expect that in less time a student shall be able to unravel the intricacies of natural phenomena? It has been said that no Greek scholarship is possible for a student who begins the study of that language in college. Is it supposed that scientific scholarship is any more possible under such conditions?

In order to teach successfully the *results* of science to college students, I have no desire that they should have any preliminary preparation. It has been my duty for more than thirty years to present the elements of chemistry to the youngest class in one of our colleges, and I have never had any reason to complain of their want of interest in the subject. Indeed, I regard it as a great privilege to be the first to point out to enthusiastic young men the wonderful vistas which modern science has opened to our view. So far as their temporary interest is concerned, I should greatly prefer that they had never studied the subject before coming to college. But even enthusiastic interest in popular lectures is not scientific culture. A few men in every class always have been, and will continue to be, so far interested as to make the cultivation of science the business of their lives. But such men always labor under the disadvantages resulting from a want of early training, and these obstacles repel a large number whose natural tastes and abilities would otherwise have fitted them for a scientific calling. The change from one system of culture to another, at the age of eighteen, has all the disadvantages of changing a profession late in life. Nevertheless, the college will always continue to educate a number of men of science in this way. Most of these men become teachers, and no one questions that their previous linguistic training makes them all the more forcible expositors of scientific truth. It is not for such persons that I desire any change. I am, however, most anxious that the university should do its part in educating that important class of men who are to direct the industries and develop the material resources of our country. Such men can be led to appreciate, and will give time to acquire, an elegant use of language, but they will not devote four or five years of their lives to purely linguistic training, and, if we do not open our doors to them, they will be forced to content themselves with such education as high-schools, or, at best, technical schools can offer. But, while they will thus lose the broader knowledge and larger scope which a university education affords, the university will also lose their sympathy and powerful support. Such students are now wholly repelled from the university, and, under a more liberal policy, they would form an important and clear addition to our numbers, and—as I have said in another place—without diminishing by a single man the number of those who come to college through the classical schools.

But there is another class of young men with whom a system of education based on the study of Nature would, as I am convinced, be more successful than the prevailing system of linguistic culture: I refer to those who now come to college, some of them through the influence of family tradition, some of them through the expectation of social advantage, and a still larger number on account of the attractions of college-life. Many of these are men who, with poor verbal memories, or want of aptitude for recognizing abstract relations, can never become classical scholars with any exertion that they can be expected to make, but who can often be educated with success through their perceptive faculties. These men are the dunces of the classical department, they add nothing to its strength, and in every classical school are a hindrance to the better students; but some of them may become able and useful men, if their interest can be aroused in objective realities. Of our present students, it is only this class that the proposed changes would really affect. Those who have tastes and aptitudes for linguistic studies would continue to come through the old channels, and of such only can classical scholars be made.

I know very well it is said that, although the classical department would be glad to be rid of this undesirable element, yet the change could not be made without endangering the continuance of the study of Greek in many of our classical schools. But can the university be justified in continuing a requisition which is recognized to be opposed to the best interests of an important class of its patrons? And certainly it is not necessary to protect the study of Greek in this country by any such questionable means. I have a great deal more faith myself in the value of classical scholarship than many of my classical colleagues appear to possess. Never has one word of disparagement been heard from me. I honor true classical scholarship as much as I despise the counterfeit. To maintain that the class of classical dunces, to whom I have referred, appreciate the beauties of classical literature or derive any real advantage from the study is, in my opinion, to maintain a manifest absurdity. Fully as much do the convicts in a treadmill enjoy the beauties of the legal code under which they are compelled to work; and if, as Chief-Justice Coleridge has recently maintained, in his speech at New Haven, classical scholarship is the best preparation for the highest distinctions in church and state, certainly its continuance does not depend on the minimum requisition in Greek of this university.* The "new culture," although a much "younger industry," does not ask for any such artificial protection. It only asks for an opportunity to show what it can accomplish, and this opportunity it has never yet had. Even if the largest liberty were granted, those who seek to promote a genuine education, based on natural science, would labor under the greatest disadvantages. Not only is the apparatus required for the new culture far more expensive than that of an ordinary classical school, but also more personal attention must be given to each scholar, and the ordinary labor-saving methods of the class-room are wholly inapplicable. In the face of such obstacles as these conditions present, the new culture can advance only very gradually; and, amid the rivalry of the old system, it can only succeed by maintaining a very high degree of efficiency. The new way will certainly not offer any easier mode of admission to college than the old; and when it is remembered that the classical system has the control of all the endowed secondary schools, the prestige of past success,

* This article was written and read to the Faculty of Harvard College shortly after Lord Coleridge's visit to the United States, in the autumn of 1883.

and the support of the most powerful social influence, it is difficult to understand on what the opposition to the free development of the "new education" is based. Are not gentlemen, who have been talking of a revolution in education, taking counsel of their fears rather than of their better judgment; and are they not forgetting that the teachers of natural science have the same interest in upholding the principles of sound education as have their classical colleagues? Certainly there can be no question that, in the future as in the past, they will ever seek to maintain the integrity of all the great departments of the university unimpaired. It has happened before this that the judgment, even of intelligent men, has been warped by their class relations or supposed interests; but as, in this country, the learned class has no control of government patronage, we may at least hope that the discussion of the Greek question will never assume with us the great bitterness that a similar controversy has aroused in Germany.

There has been a great deal said in this discussion about the "humanities," and it has been assumed that, while the analysis of the Greek verb is "humanizing," the analysis of the phenomena of Nature is "materializing." I can discover nothing humanizing in the one or the other, except through the spirit with which they are studied, and I know by experience that the spirit with which the study of the Latin and Greek grammars is often enforced is most demoralizing. Those who have been born with a facility for language may laugh at this statement; but a boy who has been held up to ridicule for the want of a good verbal memory, denied him by his Creator, long remembers the depressing effect produced, if not the malignity aroused, by the cruelty. Many are the men, now eminent in literature as well as science, who have experienced the tyranny of a classical school, so graphically described in the autobiography of Anthony Trollope; and many are the boys who might have been highly educated if their perceptive faculties had been cultivated, whose career as scholars has been cut short by the same tyranny.

Again, a great deal has been said about specialization at an early age, as if the study of Nature were specializing while the study of Latin metres and Greek accents was liberalizing. But how could specialization be more strikingly illustrated than by a system which limits a boy's attention between the ages of twelve and twenty to linguistic studies to the almost entire exclusion of a knowledge of that universe in which his life is to be passed, and which so limits his intellectual training that his powers of observation are left undeveloped, his judgments in respect to material relations unformed, and even his natural conceptions of truth distorted? Now, although a special culture which has such mischievous results as these may be necessary in order to command that power over language which marks the highest literary excellence, and although a university should foster this culture by all legitimate means, yet to enforce it upon every boy who aspires to be a scholar, whatever may be his natural talents, is as cruel as the Chinese practice of cramping the feet of women in order to conform to a traditional ideal of beauty. Indeed, an instructor in natural science has very much the same difficulty in training classical scholars to observe that a dancing-master would have in teaching a class of Chinese girls to waltz.

Again, it has been said that while the opportunities for scientific culture in college are ample, no one will oppose such a modification of the requisitions for admission as the conditions of this culture demand, provided only we label the product of such culture with a descriptive name. Call the product of your scientific culture Bachelors of Science, we have been told, and you may arrange the requisites of admission to your own courses as you choose. I am forced to say that this argument, however specious, is neither ingenuous nor charitable. If you will label the product of a purely linguistic culture with an equally descriptive name; if, following the French usage, you will call such graduates Bachelors of Letters, we shall not object to the term Bachelors of Science; or, without making so great an innovation, I, for one, should have no objection to a distinction between Bachelors of Arts in Letters and Bachelors of Arts in Science. But it is perfectly well understood that in this community the degree of Bachelor of Arts is for most men the one essential condition of admission to the noble fraternity of scholars, to what has been called the "Guild of the Learned." To refuse this degree to a certain class of our graduates is to exclude them from such associations and from the privileges which they afford; and this is just what is intended. Hence I say that the argument is not ingenuous, and it is not charitable because it implies that a class of men who profess to love the truth as their lives are seeking to appear under false colors. To cite examples from my own profession only I have always maintained that such men as Davy, Dalton, and Faraday were as truly learned, as highly cultivated, and as capable of expressing their thoughts in appropriate language, as the most eminent of their literary compeers, and I shall continue to maintain this proposition before our American community, and I have no question that sooner or later my claim will be allowed, and the doors of the "Guild of the Learned" will be opened to all scholars who have acquired by cultivation the same power which these great men held in such a pre-eminent degree by gift of Nature.

Lastly, I am persuaded that in a large body politic like this it is unwise, and in the long run futile, to attempt to protect any special form of culture at the expense of another. If one member suffers, all the members suffer with it; and what is for the interest of the whole is in the long run always for the interest of every part. I would welcome every form of culture which has vindicated its efficiency and its value, and in so doing I feel that I should best promote the interests of the special department which I have in charge.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXXVI.—DIET FOR THE GOUTY.

A CORRESPONDENT from Hereford refers to the concluding paragraph of my last paper "as too valuable to let slip, without making practical use of it," and, accordingly, asks for further information concerning the salts that should be contained in our food, and "in what other form can a poor mortal obtain them."

As the question may have presented itself to many other readers, I will answer it here, especially as I can speak from practical experience of the miseries that may be escaped by understanding and applying it. I inherit what is called a "lithic-acid diathesis." My father and his brother were martyrs to rheumatic gout, and died early in consequence. I had a premonitory attack of gout at the age of twenty-five, and other warning symptoms at other times, but have kept the enemy at bay during nearly forty years by simply understanding that this lithic acid (stony acid) combines with potash, forming thus a soluble salt, which is safely excreted. Otherwise it is deposited here or there, producing gout, rheumatism, stone, gravel, and other dreadfully painful diseases, which are practically incurable when the deposit is fairly established. By effecting the above-named combination in the blood, the deposition is prevented.

The potash required for the purpose exists in several conditions: First, in its uncombined state as caustic potash. This is poison, for the simple reason that it combines so vigorously with organic matter that it would decompose the digestive organs themselves if presented to them. The lower carbonate is less caustic, the bicarbonate nearly, but not quite, neutral. Even this, however, should not be taken *as food*, because it is capable of combining with the acid constituents of the gastric juice.

The proper compounds to be used are those which correspond to the salts existing in the juices of vegetables and flesh—viz., compounds of potash with *organic* acids, such as tartaric acid, which forms the potash salt of the grape, such as citric acid, with which potash is combined in lemons and oranges; malic acid, with which it is combined in apples and many other fruits; the natural acids of vegetables generally; lactic acid in milk, etc.

All these acids, and many others of similar origin, are composed of carbon, oxygen, and hydrogen, held together with such feeble affinity that they are easily dissociated or decomposed by heat. This may be shown by heating some cream of tartar or tartaric acid on a strip of metal or glass. It will become carbonized to a cinder, like other organic matter. If the heat is raised sufficiently, this cinder will all burn away to carbonic acid and water in the case of the pure acid, or will leave carbonate of potash in the case of cream of tartar or other potash salt.

Unless I am mistaken, this represents violently what occurs gradually and mildly in the human body, which is in a continuous state of slow combustion so long as it is alive. The organic acids of the potash salts suffer slow combustion, give off their excess of carbonic acid and water to be breathed out, evaporated, and ejected, leaving behind their potash, which combines with the otherwise stony lithic-acid tormentor just when and where he comes into separate existence by the organic actions which effect the above-described slow combustion.

If we take potash in combination with a mineral acid, such as the sulphuric, nitric, or hydrochloric, no such decomposition is possible; the bonds uniting the elements of the mineral acid are too strong to be sundered by the mild chemistry of the living body, and the mineral acid, if separated from its potash base, would be most mischievous, as it precipitates the lithic acid in its worst form.

For this reason, all free mineral acids are poisons to those who have a lithic-acid diathesis; they may even create it where it did not previously exist. Hence the iniquity of cheapening the manufacture of lemonade, ginger-beer, etc., by using dilute sulphuric or hydrochloric acid as a substitute for citric or tartaric acid. I shall presently come to the cookery of wines, and have something to say about the mineral acids used in producing the choicer qualities of some very "dry," high-priced samples that, according to my view of the subject, have caused the operations of lithotomy and lithotrity to be included among the luxuries of the rich.

It should be understood that, when I recommended the use of bicarbonate of potass for the solution of casein, all these principles were kept in view, including the objection to the bicarbonate itself. In the case of the cheese the quantity recommended was based on an estimate of the quantity of lactic acid existing in the cheese and capable of leaving the casein to go over to the potash. In the case of the peas the quantity is difficult to estimate, owing to its variability. The more correct determination of such quantities is among the objects of further research, and which I alluded to in my last.

Speaking generally it is not to the laboratory of the chemist that we should go for our potash salts, but to the laboratory of nature, and more especially to that of the vegetable kingdom. They exist in the green parts of all vegetables. This is illustrated by the manufacture of commercial potash from the ashes of the twigs and leaves of timber-trees. The more succulent the vegetable the greater the quantity of potash it contains, though there are some minor exceptions to this. As I have already stated, we extract and waste a considerable proportion of these salts when we boil vegetables and throw away the *potage*, which our wiser and more thrifty neighbors add to their every-day *mênu.* When we eat raw vegetables, as in salads, we obtain all their potash.

Fruits generally contain important quantities of potash salts, and it is upon these especially that the possible victims of lithic acid should rely. Lemons and grapes contain them most abundantly. Those who can not afford to buy these as articles of daily food may use cream of tartar, which, when genuine, is the natural salt of the grape, thrown down in the manner I shall describe when on the subject of the cookery of wines.

At the risk of being accused of presumption, I must here protest, as a chemist, against one of "the fallacies of the faculty," or of certain members of the faculty, viz., that of indiscriminately prohibiting to gouty and rheumatic patients the use of acids or anything having an acid taste.

This has probably arisen from experience of the fact that *mineral* acids do serious mischief, and that alkaline carbonate of potash affords relief. The difference between the organic acids, which are decomposed in the manner I have described, and the fixed composition of the mineral acids does not appear to have been sufficiently studied by those who prohibit fruit and vegetables on account of their acidity. It must never be forgotten that nearly all the organic compounds of potash, as they exist in vegetables and fruit, are acid. It may be desirable, in some cases, to add a little bicarbonate of potash to neutralize this excess of acid and increase the potash-supply. I have found it advantageous to throw a half-saltspoonful of this into a tumbler of water containing the juice of a lemon, and have even added to it stewed or baked rhubarb and gooseberries. In these it froths like whipped cream, and diminishes the demand for sugar, an excess of which appears to be mischievous to those who require much potash.

I must conclude this sermon on the potash text by adding that it is quite possible to take an excess of this solvent. Such excess is depressing; its action is what is called "lowering." I will not venture upon an explanation of the *rationale* of this lowering, or discuss the question of whether or not the blood is made watery, as sometimes stated.

Intimately connected with this part of my subject is another vegetable principle that I have not yet named. This is vegetable jelly, or *pectin*, the jelly of fruits, of turnips, carrots, parsnips, etc. Fremy has named it *pectose.* It is so little changed by cookery that I need say little about it beyond stating the fact that an acid may be separated from it which has been named pectic acid, the properties and artificial compounds of which appear to me to suggest the theory that the natural jelly of fruits largely consists of pectites of potash or soda or lime. We all know the appearance and flavor of currant-jelly, apple-jelly, etc., which are composed of natural vegetable jelly plus sugar.

The separation of these jellies is an operation of cookery, and one that deserves more attention than it receives. I shall never forget the *rahat lakoum* which I once had the privilege of eating in the kitchen of the seraglio of Stamboul, in the absence at the summer palace of the sultana and the other ladies for whom it was prepared. Its basis was the pure pectose of many fruits, the inspissated juices of grapes, peaches, pineapples, and I know not what others. The sherbet was similar, but liquid. Well may they obey the Prophet and abstain from the grosser concoctions that we call wine when such ambrosial nectar as this is supplied in its place! It is to imperial tokay as tokay is to table-beer!

The "lumps of delight" sold by our confectioners are imitations made of flavored gelatine. Similar substitutes are sold in Constantinople. The same as regards the sherbet.

I conclude this part of my subject by re-echoing Mr. Gladstone's advocacy of the extension of fruit-culture. We shamefully neglect the best of all food, in eating and drinking so little fruit. As regards cooked fruit, I say jam for the million, jelly for the luxurious, and juice for all. With these in abundance, the abolition of alcohol will follow as a necessary result of natural nausea.

XXXVII.—COUNT RUMFORD AND THE BAVARIAN BEGGARS.

I must not leave the subject of vegetable cookery without describing Count Rumford's achievements in feeding the paupers, rogues, and vagabonds of Munich. An account of this is the more desirable, from the fact that the "soup" which formed the basis of his dietary is still misunderstood in this country, for reasons that I shall presently state.

After reorganizing the Bavarian army, not only as regards military discipline, but in the feeding, clothing, education, and useful employment of the men, in order to make them good citizens as well as good soldiers, he attacked a still more difficult problem—that of removing from Bavaria the scandal and burden of the hordes of beggars and thieves which had become intolerable. He tells us that "the number of itinerant beggars of both sexes, and all ages, as well foreigners as natives, who strolled about the country in all directions, levying contributions from the industrious inhabitants, stealing and robbing, and leading a life of indolence and most shameless debauchery, was quite incredible"; and further, that "these detestable vermin swarmed everywhere, and not only their impudence and clamorous importunity were without any bounds, but they had recourse to the most diabolical acts, and most horrid crimes, in the prosecution of their infamous trade. Young children were stolen from their parents by these wretches, and their eyes put out, or their tender limbs broken and distorted, in order, by exposing them thus maimed, to excite the pity and commiseration of the public." He gives further particulars of their trading upon the misery of their own children, and their organization to obtain alms by systematic intimidation. Previous attempts to cure the evil had failed, and the public had lost all faith in further projects, and therefore no support was to be expected for Rumford's scheme. "Aware of this," he says, "I took my measures accordingly. To convince the public that the scheme was feasible, I determined first, by a great exertion, to carry it into complete execution, and *then* to ask them to support it."

He describes the military organization by which he distributed the army throughout the country districts to capture all the strolling provincial beggars, and how, on January 1, 1790, he bagged all the beggars of Munich in less than an hour by means of a well-organized civil and military *battue*, the New-Year's-Day being the great festival when all the beggars went abroad to enforce their customary black-mail upon the industrious section of the population. Though very interesting, I must not enter upon these details, but can not help stepping a little aside from my proper subject to quote his weighty words on the ethical principles upon which he proceeded. He says that "with persons of this description, it is easy to be conceived that precepts, admonitions, and punishments would be of little avail. But, where precepts fail, *habits* may sometimes be successful. To make vicious and abandoned people happy, it has generally been supposed necessary, *first*, to make them virtuous. But why not reverse this order? Why not make them first *happy* and then virtuous? If happiness and virtue be *inseparable*, the end will as certainly be attained by one method as by the other; and it is most undoubtedly much easier to contribute to the happiness and comfort of persons in a state of poverty and misery than, by admonitions and punishments, to improve their morals."

He applied these principles to his miserable material with complete success, and referring to the result exclaims, "Would to God that my success might encourage others to follow my example!" Further examination of his proceedings shows that, in order to follow such example, a knowledge of first principles and a determination to carry them out in bold defiance of vulgar ignorance, general prejudice, and polite sneering, are necessary.

Having captured the beggars thus cleverly, he proceeded to carry out the above-stated principle, by taking them to a large building already prepared, and where "everything was done that could be devised to make them *really comfortable*." The first condition of such comfort, he maintains, is cleanliness, and his dissertation on this, though written so long ago, might be inscribed in letters of gold over the portals of our Health Exhibition of to-day.

Describing how he carried out his principles, he says of the prisoners thus captured: "Most of them had been used to living in the most miserable hovels, in the midst of vermin and every kind of filthiness, or to sleep in the streets, and under the hedges, half naked and exposed to all the inclemencies of the seasons. A large and commodious building, fitted up in the neatest and most comfortable manner, was now provided for their reception. In this agreeable retreat they found spacious and elegant apartments, kept with the most scrupulous neatness; well warmed in winter, and well lighted; a good, warm dinner every day, *gratis*, cooked and served up with all possible attention to order and cleanliness; materials and utensils for those that were able to work; masters *gratis* for those who required instruction; the most generous pay, *in money*, for all the labor performed; and the kindest usage from every person, from the highest to the lowest, belonging to the establishment. Here in this asylum for the indigent and unfortunate no ill-usage, no harsh language is permitted. During five years that the establishment has existed, not a blow has been given to any one, not even to a child by his instructor."

This appears like the very expensive scheme of a benevolent Utopian; but, to set my readers at rest on this point, I will anticipate a little by stating that, although at first some expense was incurred, all this was finally repaid, and, at the end of six years, there remained a net profit of one hundred thousand florins "after expenses of every kind, salaries, wages, repairs, etc., had been deducted."

I must not dwell upon his devices for gradually inveigling the lazy creatures into habits of industry, for he understood human nature too well to adopt the jailer's theory, which assumes that every able-bodied man can do a day's work daily, in spite of previous habits. Rumford's patients became industrious ultimately, but were not made so at once.

This development of industry was one of the elements of financial and moral success, and the next in importance was the economy of the commissariat, which depended on Rumford's skillful cookery of the cheapest viands, rendering them digestible, nutritious, and palatable. Had he adopted the dietary of an English workhouse or an English prison, his financial success would have been impossible, and his patients would have been no better fed, nor better able to work.

The staple food was what he calls a "soup," but I find, on following out his instructions for making it, that I obtain a porridge rather than a soup. He made many experiments, and says: "I constantly found that the richness or quality of a soup depended more upon a proper choice of the ingredients, and a proper management of the fire in the combination of these ingredients, than upon the quantity of solid nutritious matter employed; much more upon the art and skill of the cook than upon the sum laid out in the market."

Our vegetarian friends will be interested in learning that at first he used meat in the soup provided for the beggars, but gradually omitted it, and the change was unnoticed by those who ate, and no difference was observable as regards its nutritive value.

In 1790 little, or rather nothing, was known of the chemistry of food. Oxygen had been discovered only sixteen years before, and chemical analysis, as now understood, was an unknown art. In spite of this, Rumford selected as the basis of his soup just that proximate element which we now know to contain, bulk for bulk, more nutritive matter than any other that exists either in the animal or vegetable kingdom, viz., *casein*. He not only selected this, but he combined it with those other constituents of food which our highest refinements of modern practical chemistry and physiology have proved to be exactly what are required to supplement the casein and constitute a complete dietary. By selecting the cheapest form of casein and the cheapest sources of the other constituents, he succeeded in supplying the beggars with good hot dinners daily at the cost of one halfpenny each. The cost of the mess for the Bavarian soldiers under his command was rather more, viz., twopence daily, three farthings of this being devoted to pure luxuries, such as beer, etc. The details of the means by which he achieved these notable results will be stated in my next.

THE ORIGIN OF CULTIVATED PLANTS.

By M. ALPHONSE DE CANDOLLE.*

THE traditions of the ancient peoples, embellished by the poets, have commonly attributed the first steps in agriculture and the introduction of useful plants to some divinity, or at least to some great emperor or *inca*. Reflection teaches us that this is not probable, and the observation of the agricultural efforts among the savages of our own age indicates that the real facts in the case are quite different. Generally, in the progressive steps that lead to civilization the beginnings are weak, obscure, and narrow. There are reasons why this should be so in agricultural and horticultural initiatives. There are many gradations between the custom of gathering fruits, seeds, or roots in the field and that of regularly cultivating the plants which yield such products. A family may scatter seeds around its home, and the next year seek the same product in the forest. Some fruit-trees may be growing around a house, and we not know whether they have been planted there, or the hut has been built near them for convenience of access to them. Wars and hunting often interrupt efforts at cultivation. Rivalries and jealousies may make one tribe slow in imitating another. If some great personage ordains the cultivation of a plant and institutes some ceremony in demonstration of its utility, it is probably after obscure persons have spoken of it and successful experiments have been made upon it. Previous to such demonstrations adapted to impress the multitude, a shorter or longer period of

* From his new book, "The Origin of Cultivated Plants," recently published in Paris.

local and ephemeral trials must have passed. Determining influences were needed to incite these trials, to secure their renewal, and bring them to success. We can easily understand what they were.

The first thing necessary was to have within reach some plant offering qualities desirable to all men. The most backward savages are acquainted with the plants of their own country ; but the Australians and Patagonians are examples to show that, if they do not judge them productive and easy to raise, they do not think of putting them under cultivation. Other conditions are quite evident : a climate not too rigorous ; in hot countries, freedom from too long drought ; some degree of security and fixedness ; and, last, a pressing necessity resulting from failure of resources in fishing, hunting, or the production of the nutritious fruits of native plants, such as the chestnut, the date, the banana, or the bread-fruit. When men can live without working, that is what they prefer. Besides, the element of chance in hunting and fishing tempts primitive men—and some civilized ones too—more than do the difficult and regular labors of agriculture. To return to the species which savages may be disposed to cultivate. They find them sometimes in their own country, but frequently they receive them from neighboring people who are more favored by natural conditions than they, or have already entered upon some degree of civilization. Unless a people is cantoned in an island or in some place difficult of access, it will speedily receive those plants discovered elsewhere whose advantageous qualities are evident, and this will divert them from the cultivation of the inferior species of their own country. History teaches us that wheat, maize, the yam, several species of the genus *Panicum*, tobacco, and other plants—particularly annual ones—became widely diffused before the historical period. These good species encountered and arrested the timid efforts which might have been made here and there with less productive or less agreeable plants. In our own days, we see, in different countries, wheat taking the place of rye, maize preferred to buckwheat, and many grains, vegetables, and economical plants falling into neglect because other species, often brought from a distance, offer more advantages. The disproportion in value is, however, less between plants already cultivated and improved than formerly existed between cultivated plants and quite wild ones. Selection—that grand factor which Darwin has had the merit so fortunately to introduce into science—plays an important part when agriculture is once established ; but in every period, and especially in the beginning, the quality of the species is more important than the selection of varieties.

The various causes which favor or oppose the beginnings of agriculture will explain why some regions have been for thousands of years populated by cultivators, while others are still inhabited by wandering tribes. Rice and several legumes in Southern Asia, barley and wheat in Mesopotamia and Egypt, several grain-plants in

Africa, maize, the potato, the yam, and the manioc in America, were evidently easily and soon cultivated under the inducements offered by their obvious good qualities and favorable climatical conditions. Centers were thus formed, and hence the most useful species were diffused. In the north of Asia, Europe, and America, the temperature is unfavorable, and the indigenous plants are sparsely productive ; but, as the resources of hunting and fishing are available, the introduction of agriculture could be delayed, and the people could do without the valuable species of the South without suffering much. It was otherwise in Australia, Patagonia, and Southern Africa. The plants of the temperate regions of our hemisphere could not reach these countries on account of the distance, and those of the intertropical zone were excluded from them by the excessive drought or the absence of high temperatures. At the same time the native species were miserable in quality. It was not want of intelligence or of security alone that prevented the inhabitants from cultivating them. Their nature also discouraged the effort to such an extent that the Europeans, during the hundred years they have been in these countries, have only attempted the cultivation of a single species, the tetragonia, an inferior green herb. I do not forget that Sir Joseph Hooker has enumerated more than a hundred Australian species that might be used in some way ; but, in fact, they have not been cultivated, and they are not cultivated, with all the improved processes which the English colonists possess. This demonstrates the principle I have just announced, that the quality of the species has an influence on the selection, and that there must be real qualities in a wild plant to induce an effort to cultivate it.

Notwithstanding the obscurity that surrounds the beginnings of agriculture in different regions, it is settled that the dates vary exceedingly. One of the earliest examples of cultivated plants is drawn from Egypt, in the shape of a design representing figs in one of the pyramids of Gizeh. The date of the construction of the monument is uncertain ; authors vary in assigning it to from fifteen hundred to four thousand two hundred years before the Christian era. If we assign it to two thousand years before Christ, we would have an antiquity of four thousand years for the fig. Now, the pyramids can have been constructed only by a numerous people, organized and civilized to a certain degree, who must consequently have had an established agriculture, going back several centuries, at least, for its origin. In China, twenty-seven hundred years before Christ, the Emperor Chennung introduced a ceremony in which, every year, five species of useful plants were sown—viz., rice, soja, wheat, and two kinds of millet. These plants must have been cultivated for some length of time in some places to have attracted the attention of the emperor at this period.

Agriculture seems, then, to have been as ancient in China as in Egypt.

The constant intercourse of the latter country with Mesopotamia justifies us in presuming that cultivation was almost contemporaneous in the regions of the Euphrates and the Nile. Why may it not have been quite as ancient in India and the Indian Archipelago? The history of the Dravidian and Malaysian people does not go back very far, and is very obscure; but there is no reason for presuming that cultivation, particularly on the banks of the rivers, did not begin among them a very long time ago.

The ancient Egyptians and the Phœnicians propagated numerous plants in the region of the Mediterranean; and the Aryan peoples, whose migrations toward Europe began nearly twenty-five hundred or, at latest, two thousand years before Christ, spread many species which had already been cultivated in Western Asia. We shall see, in studying the history of particular species, that some plants were probably already cultivated in Europe and Northern Africa. This is indicated by names in languages that prevailed before the Aryans came: the Finnish, Basque, Berber, and Guanche (of the Canary Islands). The remains, called Kjökkenmöddings, of the ancient habitations of Denmark have, however, as yet furnished no traces of cultivation, and no evidence of the possession of a metal. The Scandinavians of that period lived entirely by fishing, hunting, and, perhaps accessorily, on indigenous plants—such as those of the cabbage kind—which were not of a nature to leave traces of themselves in the manure-heaps, and which, perhaps, did not require cultivation. The absence of metals does not imply, in those northern countries, a greater antiquity than the age of Pericles, or even of the best period of the Roman Republic. Agriculture was finally introduced later, after bronze had become known in Sweden, a country then still far from civilized lands. A sculpture of a plow, drawn by two oxen and guided by a man, has been found in the remains of that epoch.

The ancient inhabitants of Switzerland cultivated several plants, some of which originated in Asia, when they had instruments of polished stone, but not of metals. M. Heer has shown that they were in communication with the countries situated to the south of the Alps. They may, in this way, have received cultivated plants from the Iberians, who occupied Gaul before the Celts. In the period when the lake-dwellers of Switzerland and Savoy were in possession of bronze, their cultivated plants were more varied. Apparently, even the lake-dwellers of Italy cultivated fewer species when they had that metal than the people of the lakes of Savoy—a fact which may have been connected with a greater antiquity, or with local circumstances. The remains of the lake-dwellers of Laybach and of the Mondsee, in Austria, also attest a quite primitive agriculture; no cereals have been found at Laybach, and only a single grain of wheat at the Mondsee. So little advanced a condition of agriculture in that eastern part of Europe is in opposition to the hypothesis, based on some words of the ancient historians, that the Aryans sojourned first in the region of the Danube, and that Thrace was civilized before Greece. Notwithstanding this example, agriculture seems to have been generally more ancient in the temperate part of Europe than we would be ready to believe from the accounts of the Greeks, who were disposed, like some modern peoples, to make all progress appear to start from their nation.

In America, if we may judge from the civilizations of Mexico and Peru, which do not go back even to the first centuries of the Christian era, agriculture was not, probably, as ancient as in Asia and Egypt. But the immense dispersion of certain kinds of cultivation—as that of maize, of tobacco, and of the yam—leads us to assign an antiquity of nearly or about two thousand years to it. History fails us in this case, and we have no resource for ascertaining anything about it, except from discoveries in archæology and geology.

WAGES, CAPITAL AND RICH MEN.*

By the Author of "Conflict in Nature and Life."

IT is no marvel that labor and capital are in conflict; and yet they are necessarily co-operative factors to the same end. What benefits capital should also benefit labor, and *vice versa*, and there is essential harmony between them, as Bastiat, Carey, Perry, and other economists insist; but the theoretical harmony thus so obvious fails in practice, and we are compelled to acknowledge the fact of actual discordance. The interests of labor are in the hands of one class, and the interests of capital in the hands of a very different class, and they naturally enough contend about a certain margin of profit, since what one class gets of this the other must necessarily do without. The war is really between laborers and the employers of laborers; and it is quite likely in the course of events that this war will become a source of anxiety and suffering far beyond what one would expect from such apparently peaceable forces. There is hardly any doubt that, if the wealthy classes in this country could have their unrestrained way in all things, they would build up an aristocracy as oppressive and disdainful as ever existed anywhere. If the so-called working-classes (not embracing those who are their own employers) could have their way, they would do even worse by precipitating the conditions of universal poverty.

I speak of labor and capital as antagonists; and this is true, though the owner of capital is not always a party to the conflict; he is so only when he uses his own capital in the employment of labor. Very largely the employer of labor is a borrower of capital, paying for the use of

* From "Reforms: their Difficulties and Possibilities." New York: D. Appleton & Co., 1884.

the same. When this is the case, there are three parties having distinct interests. The owner of capital must have "use"; the borrower of capital and employer of labor must have "profits"; and the laborer must have "wages." But it will answer all the purposes of this statement in this connection to assume that the owner and user of capital are one, and that the contest is between him and the laborer.

Laborers in the several departments of industry are as much competitors with one another as with other classes of society, and in some respects even more so. In connection with the class-feeling, which is apt to be engendered among the laborers of a particular department of industry, they come to regard the desired increase of their wages as the one thing needful for the prosperity and happiness of mankind. Allow that the additional wages are secured; then, with what result? Labor is a large item in production, and, when it is made more expensive, the cost of production is increased. This may or may not add to the commercial price of the product: if it does, the additional price must be paid by all who purchase for consumption; and, as about three fourths of all consumers in the civilized world are working-men dependent on their wages, they are now worse off than before, being taxed to better the condition of the favored few.

"That is not the intention," retorts Reformer; "we mean that the articles so produced shall be kept at their former price by reducing the profits of the employer." A good idea, which should teach modesty to the "money power"; but it has this drawback, namely, that, if capital in this particular industry is thus compelled to accept considerably less return than capital employed in other industries, it will desert this field of operations for some other which pays better, and the laborers who have their wages thus arbitrarily raised will reap the penalty for their ignorance of economical laws by finding themselves out of employment, or working on short time. Capital and enterprise could, under such circumstances, be retained in the business at all only by an increase in the price of the product through reduced production, increased demand, or other means, so as to pay both the increase of wages and the usual interest of capital and profit to management.

Reformer answers: "Such gain at the laborers' expense is precisely what galls; there is quite too much of it; and it should be restricted by public sentiment taking the form of law." Beware, my dear sir; that is just the way the other side used to do! Within the present century, even England has had laws on her statute-books restricting the freedom of laborers as laborers in the most arbitrary manner, because it was assumed that only employers understood the proper thing to have done, and they made the laws. This was a survival of barbarism in the interest of employers, and it can hardly be revived at this late day in the interest of employés. There may, indeed, be certain forms of restriction imposed on employers for the protection of laborers; as, for example, in relation to the unhealthy condition of shops, too long hours, the employment of children, etc. But these are general rules, which do not touch the right of enterprise to select its field, and, under freedom of competition, to make the most of it. Restriction within limits may be even demanded by economics as well as by humanity; but here the limits are of importance to the last degree, since disregard of them may destroy individualism and land us in state communism.

If force could be used to compel capital under some rule to surrender all or most of its gains to laborers, it would remove to a great extent the motive for saving and the incentive to enterprise, and prevent the opening of new fields for the employment of new hands, ever asking for something to do. Hoarding would take the place of investment. Wealth would still be desired for use, but not for business; and the currents along the old channels would become sluggish, and, with failure to invest for profit, would come the falling off of means for use. This is substantially what takes place during periods of great commercial depression, when loss of confidence and fear of extending credits temporarily deprive capital of its active functions, and throw labor out of employment. It is furthermore substantially the condition of things under Eastern despots, where property is not protected from spoliation, and there is, consequently, little saved for the assistance of labor, which has, in consequence, to be done at a disadvantage, and all the people are hopelessly poor.

Employers are not absolute arbiters of fate, and can not make a remunerating profit with the cost of production and the state of the market against them. Should the outlay for wages in any department of industry be so great that its products could only be sold as a loss, managers must contract operations or stop altogether, when the laborer becomes the direct and principal sufferer; and thus it is shown how easy it would be for him, if he had his own way, to destroy the industry on which he depends for support. Most laborers in the present state of their education are not a whit wiser than this implies, though some of them happily are. It is stated that committees of working-men, appointed to confer with their employers, have been known even to refuse the highest wages it would have been possible to exact, lest their product should be so weighted with cost of production as to place it at a disadvantage in the markets, and thus cripple their industry, and in the end do them more harm than good. There are few such working-men, however, and it is to be feared that they are little on the increase in number and influence. Mr. Gregg affirms (1879) that "never during the experience of a generation and a half can I remember to have seen the artisans throughout the length and breadth of the land acting so entirely in defiance of common sense and right feeling, and with so total a disregard of plain and repeated warning" ("Nineteenth Century").

"Oh," interrupts Reformer, "you are running on at a great rate, and getting in too much philosophy all at once; we mean that all laborers in all industries shall have more wages." Very well; raise their wages—and, then, with what economical result? A protective tariff raises wages, but it raises the price of products even more; and it raises wages simply because it raises prices. Any arbitrary measure which should raise wages along the whole line would so disturb the prevailing equilibrium of the economic forces as to necessitate a general readjustment which would leave the laborer no better off than before. He would find himself paying out with one hand the benefits he received with the other, and a general rise of wages, like a general rise of prices, would be no rise at all.

"We mean nothing of that sort," impatiently retorts Reformer; "how short-sighted you are! We mean that what is thus given additional to labor shall come out of interest and profit." Good again; but how will that work? We are now at the very pith of this thing. To advance wages along the whole line without increase in the price of products would transfer a part or all of what is called interest and profit from capitalists and the operators of business to the laborers. "Certainly, that is what we want in order that laborers may live with dignity and comfort worthy of human beings." Just so; no one would be more pleased than myself if this could be so. But, as I was going to say, if such an economic policy could be put in force, then the aggregate of savings for the establishment of industries and the employment of labor would be smaller than before, labor would be done in consequence at an increasing disadvantage, and the penalty would fall upon all classes, and would be most severely felt by the working-men. In this way the remedy would defeat itself, and turn out to be worse than the disease. But such an economical policy can not be put in force, because there is no element in the economical domain capable of exercising any such power.

"Then, in the name of justice and humanity, is there any relief for the working-man?" There is and there is not. There are many conditions which affect the reward of labor—such as the character of the soil, the cost of raw materials, the capital at command, the number competing for work, the facilities for exchange, and the like. With a more intelligent direction of effort, with sobriety and frugality, with restraint on the increase of numbers, working-men would certainly receive better pay, and it would do them more good. There is something more wanting than the mere increase of money wages, now so generally sought as the one thing needful. Labor is eventually paid in products which go to the support of the working-man's family, and the increased expense of his goods is often greater than the increased pay for his work. Wages and prices rise and fall nearly together, and they do so as the effect of a common cause. The actual reward of labor is thus more uniform than the money price of labor. But even here, as usual, labor is at a disadvantage, because it can not be held, as goods may, for higher prices. It is hardly possible, under such circumstances, that the working-people should be able, by any concert of action, to command their employers and dictate wages.

"It's all wrong," exclaims Reformer, indignantly; "it is slavery that men shall toil to make the rich richer!" Truly, we all wish it might be otherwise; but we are compelled to accept human nature, revolt as we may against the limits of its possibilities. The economical laws have grown out of it in the struggle of life, not by conscious purpose, but by overruling necessity, as resultants of the clashing and divergent forces of individualism and competition. Nobody is responsible; and it may be that these vast accumulations of wealth have their good as well as their evil side. If a large proportion of civilized people have not had the energy and management to push themselves into positions of plenty and comfort, it may be that even making the rich richer has points of advantage which render it a blessing rather than a curse to laboring-men themselves. Let us see.

There is a surplus beyond immediate consumption from the products of all the industries in the world: what shall be done with this surplus? If certain classes of people could have their way, what is now surplus would all be consumed by the end of the year. It is not so consumed now, because those who would like it for consumption can not get it. Not only the ignorant and the improvident would so elect, but the more intelligent, such as are employed in offices and places of considerable trust. Most who live on salaries manage to keep about even; they do not spend more, because their salaries are not greater. Then, if nobody saved—an extreme supposition—what would be the result? Civilization could not advance, the world could not become richer in the comforts of life, because the basis of production, capital, that is, the savings of labor, would not accumulate. Indeed, if there were not savings to be constantly invested for the repair of waste and wear, there would soon be a calamitous falling off everywhere in the comforts of life. It is capital that makes labor tell in successful production; and, without capital, we should be in the condition of barbarians, of savages even. Then, what is the part the accumulator plays? The savings from labor above consumption fall into his hands, where they are largely conserved for use. His capital seeks investment, it utilizes invention and discovery; it establishes industries and employs labor; it distributes the products; and the average of human comfort is constantly on the increase through this means. The savings of labor which have fallen so largely into the hands of the few, making them rich men, have built our railroads, steamships, telegraphs, manufactories, thus in many ways adding to the means of production, and the facilities of commerce at home and abroad. These saved earnings in the hands of men seeking investment for profit have increased the wealth, resources, and refinements of civilization, made abundance possible, and brought it within reach of all, except the unfortunate, or the indolent and improvident. The industrious and economical poor man is better off to-day than if laboring-men all through the past could have had what so many of them are at present clamoring for. This method of attaining the good does not, of course, come up to the standard of perfection; it is not harmonious and artistic; it is very far from being equitable, if tried by an ideal standard; still, it is the best possible—human nature being what it has been and still is, this taint of evil is the inevitable condition of compassing the good.

Let us suppose that capitalists and managers get less, and the workers more, of the common products. So far this would seem to be greater justice than now obtains. Suppose further—which, however, is absurd—that just as much will now be saved for business as before, and that it is in the hands of the working-people themselves for business purposes. Can they make it tell in business as it does in the hands of men whose shrewdness and skill bring them to the front by a sort of natural selection? Would there not be a great want of unity and concert of action among the million holders of this surplus to render it comparatively inefficient for the purposes of production? Would it not come to pass that, through the misapplication of capital, the masses of the people, in drawing a larger proportion of the common earnings, would soon find a smaller aggregate to draw from? Is it not plain that here is a case in which seeming justice may defeat justice, and cause the working-man after a brief triumph to fall into a worse condition than before? And this would be true, even on the supposition that the proletariat would save as much as the accumulating classes now save; but they would not so save—they would consume; there would be less capital, and business would suffer a decline, to the detriment of all classes. It is one of the difficulties of reform that a seeming good may react into evil.

Agitators do not sufficiently keep in mind that business can not be carried on without capital, and that this capital can be had only by self-denial and by saving. Capital is not a providential gift bestowed like showers of manna from heaven. Only the industrious, enterprising, economical, well-managing, are certain to acquire capital and retain it. In making investments for production by the employment of labor, there are very generally risks to run, and these risks the party responsible for the business must wholly assume. The laborer as such has no capital to fall back upon, and can not share in losses. Is it right, therefore, that he should receive so much of the products that there would be little or nothing left for the responsibility and enterprise of management? Take two men fifty years of age: A has worked hard, lived economically, invested wisely, and saved more or less every year; he is now a capitalist and employer. B has used up his earnings as he went along, and is now working for A. Has he any just right to insist that A shall forget the past, ignore its results, and take him in as an equal partner? This is substantially what all ask for who insist that labor shall have all it produces, without regard to the part which capital plays in production. It would not be just; there would be a radical and far-reaching wrong in rewarding improvidence and shiftlessness equally with risk and enterprise. To do this would be to outrage moral government, by which an action of any kind should be followed by its fitting sequence. The practical results of such a course could not be good. We must reiterate that if, in the event of giving all to labor, there were no immediate falling off in the amount of capital, such falling off would nevertheless soon come about through mistaken investment, since the shrewd and enterprising, into whose hands capital now usually falls, are precisely those who are best qualified to discover the fields in which investments may be made to the best advantage; for it is by the utilization of such fields that the greatest amount and variety of productions are had, and most is added to the general wealth of the civilized world. Profit and utility thus go along hand in hand. But the greatest loss from the indiscriminate reward of economical misdoing would be in the actual reduction of savings and diminution of capital.

Then, what is the economical function the rich man performs? He conserves the surplus of production, holding it in trust for the good of all, and without him there would be no civilization. The accumulator, the self-made rich man, usually expends only a percentage, often a small percentage, of his income, on his own gratifications. What he retains beyond this can not go to his own behoof, and, if it helps anybody to more of the goods of life, it must, as a rule, help others; and it is precisely this surplus, thus saved and used as the basis of every industrial and commercial enterprise, that makes him rich and keeps him rich. So bound up is he with the system of civilized methods that he can not add to his wealth by successful enterprise on the methods which legitimate business requires without helping others. The worthy rich man is, indeed, a self-exalted prince of civilization, who holds his wealth in trust for the maintenance and further advancement of that civilization. Surely he is entitled to our blessings rather than to our curses.

Still, when we see wealth in the hands of the worthless who live in idleness, but to exemplify the vanities of life, while many a one who is a useful member of society, with capabilities of still greater usefulness, is struggling in the battle of life with odds against him, we may impulsively curse the lottery that favors the one and dooms the other.

> "It's hardly in a body's power
> To keep, at times, frae being sour,
> To see how things are shared;
> How best o' chiels are whiles in want,
> While coofs in countless thousands rant,
> And ken na how to wair't."

But this is largely incidental, and is an illustration of the discordances which attend on the operation of general laws in the constitution of things. There is no getting rid of such discordances; they are an inevitable part of the system, and bound fast to the good. If we are blessed with the rain, we should not repine at the disorder in the elements which sometimes accompanies it.

But, while we are compelled to take this view of the economical function of wealth, let us not do it the injustice of drawing unwarranted inferences from it. I do not lose sight of the fact that the advantages of the moneyed classes are not wholly those which accrue from the legitimate action of economical principles. These classes have always seen to it that the laws were made in their favor, thus securing for wealth and position additional leverage to make the rich richer and the poor poorer. The natural advantages which wealth gives them is not enough; they secure arbitrary privileges by legal enactment, and with these increase the distance between themselves and the masses of the people. And this is true, whether the people are the reputed rulers or not; only too often the innocent voter is unconsciously doing the political work which has been prepared for him by a dexterous hand which he does not see. I yield to none in utter execration of the unscrupulous devices whereby monopoly is "lawfully" armed to take from the substance of the people for its own aggrandizement.

In consequence of this very tendency to make a selfish and unjust use of power in government and society do the strong classes only too generally succeed in putting off labor with inadequate compensation. There is something else in life than mere money and the exuberant development of material prosperity. We could afford a little less of these, in order that the working-people might be richer in the substance of every-day life. But, when even liberal wages are not only consumed, but too often consumed in a way to injure the laborer, we see how difficult it is to hit upon the best practical thing to do. Too low wages is bad; and wages arbitrarily made extremely high would soon prove to be bad by cutting off the source from which wages are derived. I but state economical difficulties, and protest that they should not be made the occasion of unwarranted inferences.

Another point which, in this connection, I do not forget, concerns the shadows of wealth. There are certain forms of good which can not be had without wealth; but, when such wealth is secured, it brings with it certain forms of evil which have never yet been separated from the possession of wealth. But, if I attempt to show that the dreams of labor-reformers are impracticable in that they would soon reduce all to the same level of poverty, that attempt, in recognizing the economical conditions of plenty, is certainly not to be construed in support of the evils of wealth; for wealth is the very thing, whatever its drawbacks, without which civilization can not exist.

DU MOTAY'S PROCESS OF ICE-MAKING.

By G. B. SEELY.

OF all the projects that have excited the ridicule of the unimaginative of times gone by, perhaps none has appeared more exceedingly funny and chimerical than that of producing at will, by mechanism operated by heat, a freezing cold, and that without the use of ice, or any previously congealed substance, and without regard to atmospheric temperature.

In these days of rapid development of the mechanic arts, it seems hazardous to assert impossibility of any mechanical problem involving the substantial amelioration of man's condition. The manifest need of an improvement seems to be but the condition of its realization and development; sooner or later appears the embryo invention destined to be the theme of long study and continual modification, the perfected product often bearing little or no resemblance to the crude prototype that may have first embodied an idea fraught with lasting good to man. The conception once concretely realized, its beneficent results become a part of the common capital of the race, making possible still further advances in our material well-being.

While the progenitors of the race seem early to have discovered the means of producing heat artificially, for their rude arts and for their bodily comfort, it is not probable that the means of obtaining artificial cold could ever have seemed to primitive man a pressing need. Civilization is a multiplying of needs, and nothing connected with man's development seems more clear than that the adoption of artificial protection from the elements, conducing directly as it has to a material modification of Nature's means of protecting the body and providing for its wants, has not only led to the demand for readily available means of producing artificial heat, but for the means of artificial refrigeration as well.

Since the experiments of Professor Twining thirty years ago, with sulphuric ether, the problem of producing artificial cold has been attacked by many, but the basis of the more important and successful systems employed has been, as in Twining's experiments, the volatilization of a liquid *in vacuo*, by means of a gas-pump. Of the various substances available in nature for this purpose, ether and ammonia have received the most attention. Various other liquids have also been used, such as sulphide of carbon, methylic ether, chloride of methyl, chymogene, etc., and latterly sulphurous acid as used in the famous Pictet system. Compressed air has also been employed, but the mechanical labor required by this system is too costly to allow it to compete with what may be termed the volatilizing systems.

The object sought has been the most economical method of employing those substances that are capable of producing the greatest degree of cold. But a difficulty is encountered in the high pressures of the gases produced in the pump, as there is no evading the physical fact that the cold-producing power of a gas is a concomitant of its tension, or pressure varying directly therewith. Thus, ammonia, with a pressure at rest of eight atmospheres, and at work of twelve to twenty atmospheres according to the temperature, is an excellent refrigerant, but the use of a gas with such a high pressure is attended with obvious drawbacks. At the other end of the scale is ether, which is manageable at a low pressure, viz., zero at rest, and ten to fifteen pounds per square inch at work; but this advantage has its corresponding drawback, in accordance with the law above mentioned, i. e., a comparatively low refrigerating power. It is, moreover, inflammable, and, in contact with any of the lubricants used on the pump-piston, there results an unintended product of soap, which, coating the parts of the mechanism, obstructs the passage of the latent heat from the circulating medium employed for freezing. Midway between these two agents, as regards its pressure, is sulphurous acid. This gives a high degree of cold, its pressure at work being three and one half to six atmospheres, and a little over two and one half atmospheres at rest. Aside from its rather high pressure, a serious objection to its use is the liability to corrosion of the parts on contact of the liquid with moisture, sulphuric acid being thereby produced, which rapidly wears away the more important parts of the mechanism employed.

The various defects enumerated, and others incident to the use of other agents not here particularized, viz., liability to explosion, inflammability, indifferent refrigerating capacity, high vacuum, high pressure involving rapid wear and tear and danger in use, and other more or less serious drawbacks, have made the attainment of a still better system than the best of those referred to imperative. The great desideratum, it will be seen, has been a process admitting of using some of the better cold-producing agents without the dangers or annoyances due to the high tensions of their gases, or to other peculiarities of their composition. The discovery of a method by which this object could be attained is due to the genius of the late C. M. Tessié du Motay.

This eminent French chemist, acting on the suggestion of one of his associates, M. Étienne Gillet, a gentleman who had made a close study of artificial ice-making, sought to combine two or more liquids which should have the property, in combination, of mutually neutralizing the defective features they exhibited when used separately, and which should at the same time retain their desirable qualities. He instituted experiments, in conjunction with M. Auguste Rossi, which resulted in the discovery that ether, when combined with sulphurous acid, furnished a compound absolutely free from any of the defects that had previously hindered successful working. The inflammability of ether was nullified by the sulphurous acid; a perfect lubricant was obtained, and the substance had no corrosive action on the metals employed. But the most interesting feature developed by the experiment was that the ether was found to have the power of absorbing a large proportion of the gas of the sulphurous acid. This is the characteristic feature of the binary absorption system, as Du Motay termed his process. The ether, by absorbing the gas of the other constituent liquid, reduces the mechanical problem to that of liquefying a gas having a pressure not approximating that of sulphurous acid, viz., fifty to eighty pounds or more per square inch, but barely more than that of ether itself, viz., twenty pounds. The pressure of the compound at rest, like that of ether, is *nil.* In other words, the ether is found to have accomplished the greater part of the work, and a law of nature governing the action of certain chemicals in combination is availed of to reduce the mechanical labor of liquefaction to a minimum.

Since the death of Du Motay, which occurred very soon after his discovery, his associates, MM. Auguste Rossi and Leonard F. Beckwith, have continued the experiments under the Du Motay patents, with various other compounds, and have accomplished the hitherto unheard-of result of liquefying ammonia gas in the pump at a pressure of thirty-five pounds per square inch. This is accomplished by combining it with glycerine, a non-volatile, which gives up the ammonia gas in the vacuum-pump, but, when it has reached a certain tension, seizes it, so to speak, and renders it liquefiable at a fraction of its ordinary pressure.

There are various other compounds capable of giving the same results—an intense freezing power at a greatly diminished pressure, and the peculiarities of various industries employing mechanical refrigerants can thus be consulted and met by the use of whatever compound is found best adapted thereto.

There are certain general features common to all the systems employing a liquid volatilizable in the vacuum-pump, but the peculiar features of the binary absorption process admit of such a simplifying of the mechanical appliances employed as to materially distinguish their construction from that of other systems.

The freezing agent, ethylo-sulphurous dioxide, or glycerine and ammonia, or whatever be the compound employed, is placed within the "refrigerator," which consists of tubular coils immersed in an uncongealable mixture. A double-acting vacuum-pump volatilizes the agent in the refrigerator coils, and this is attended with the development of an intense cold, which is communicated to the surrounding mixture, and the latter, by means of a circulating pump, is made to flow through a suitable tank containing vessels of water to be frozen, or, if air-cooling only be desired, through iron tubing placed along the walls or ceiling of the chamber to be cooled. The discharge-pipe of the circulating pump communicates with a condenser, which consists of a tubular vessel immersed in a tank containing cooling water taken from any convenient source and kept in constant circulation. The volatilized liquid is expelled from the pump into this condenser, where the process of condensation or liquefaction of the gas is completed. The restored liquid is then returned to the refrigerator by suitable connections, to be again volatilized, and so on continuously, the waste of the agent being but trifling.

The time consumed in the process of freezing the water-cans ranges from twenty-four to thirty-six hours. The more perfect the insulation of the tanks in which the water-cans are immersed, the more quickly is the latent heat extracted from the water; and this, after all, is the problem involved in artificial freezing. To speak of the manufacture of cold, though popularly comprehensible and convenient, is to misapply terms. In one sense heat seems to be but an incident of the cosmic order, an exception to a state of things pervading interstellar space, and toward which the warm earth, and her sister planets, and all the burning orbs of heaven, are gradually tending. In producing cold we therefore seem but to assist Nature to re-establish, in an infinitesimal degree, the state of comparative molecular inactivity that distinguishes cold from heat, and which characterizes the vacuum.

The need of an efficient system of artificial refrigeration is constantly increasing. Not alone in warm countries is ice rapidly becoming a universal necessity, but, in myriad industries in temperate climes, the economy experienced by using air-cooling contrivances in the place of Nature's unwieldy, slippery, and not always obtainable product, has long since been satisfactorily demonstrated by the widespread use of various systems of machines.

In the years to come, there may arise some engineering genius bold enough to conceive and skillful enough to execute a plan for tapping the limitless reservoir of cold that pervades interplanetary space, and bringing a supply, regulable at will, to a sweltering world. This would be a highly satisfactory solution of the problem of such interest to nine tenths of humanity for a large portion of the year, how to keep cool. Pending, however, the realization of such a scheme, of which it must be confessed there is no immediate prospect, it is difficult to discern any way to an improvement, in this branch of physics, on the latest product of French inventive genius.

THE PHYSIOLOGICAL ASPECT OF MESMERISM.*

By J. N. LANGLEY, F.R.S.

SCATTERED about in the literature of the seventeenth and eighteenth centuries are many records of the cure of divers human maladies in simple and mysterious-seeming ways. Valentin Greaterakes, in Charles II's reign, was, we are told, "famous for curing various diseases and distempers by a stroak of the hand only." His power, he thought, was a special gift from Heaven. Many people, however, were not slow to say that he had dealings with the devil. In some cases wonders were wrought by touching the affected parts of the patient with a magnet. Maxwell, who in 1679 published a short treatise on magnetic medicine, attributed the cures brought about by this, and by some other unusual forms of medical practice, to the accumulation of a subtile fluid in the body of the patient. This subtile fluid was diffused through all things in nature; a fortunate few among men had an inborn power of controlling its distribution. Such men could cure all diseases; they could indeed, he says, by adding to their own proper quantum of fluid, make themselves live forever, were not the influence of the stars adverse.

In 1775 the theory of animal magnetism was put forward in Vienna by Friedrich Anton Mesmer. Neither his theories nor his facts differ very greatly from those of some of his predecessors. There exists, he said, in nature a universal fluid; in virtue of this, the human body possesses "properties analogous to those of a magnet; there are to be distinguished in it poles equally different and opposite, which may even be communicated, changed, destroyed, and restored; even the phenomenon of inclination is observed therein." By means of this magnetic fluid all the maladies of man could be healed. A few years later Mesmer left Vienna for Paris. At first he magnetized his patients by gazing steadily at them, or by means of "passes"; but, as patients became more numerous, he brought them into a proper magnetic condition by other methods, often of a very fantastic nature. The patients did not, when magnetized, all show the same symptoms: some passed into a heavy sleep, some became insensible to touch, or even to stimuli ordinarily painful; some became cataleptic, some were seized with local or general convulsions. This last condition was called a crisis, and was the triumph of the mesmerizer, the moment when the disease was considered to be forcibly expelled from the system. Nowadays it is the last state a physician would care to produce in a patient.

For a time Mesmer's success was enormous. His admirers subscribed for him a sum of nearly 350,000 francs, receiving in return

* Abridged from an address delivered at the Royal Institution of Great Britain, March 14, 1884.

details as to the method of magnetization. In Paris the belief in the power of Mesmer to cure diseases soon waned; but by this time he had made a stir in the world, and had drawn attention to a number of facts which were either only locally known, or largely disregarded. Mesmer devoted himself chiefly to curing patients, and it must be added, to receiving fees; but about ten years after the time of his coming to Paris it was found that a state resembling somnambulism, or sleep-walking, could be produced in some persons by magnetizing them. This gave a stimulus to the investigation of what I may call the magical side of the phenomena. This magical side had always been present, but in the height of Mesmer's power had not been much regarded. Of the magic of animal magnetism I will say one word more presently.

The term animal magnetism lingered long, but has now happily fallen into disuse, either mesmerism or hypnotism being used in its stead. "Hypnotism" we owe to Dr. Braid, of Manchester, who, from 1841 to the time of his death in 1860, subjected all the phenomena said to be produced in the magnetic state to a searching investigation. Braid is the founder of mesmerism in its scientific aspect. Hypnotism and mesmerism, as commonly used now, are synonymous terms; it would be advantageous, I think, if we could make a distinction between them. We might, for example, use the term hypnotism to embrace all those phenomena which are proved, and the term mesmerism to embrace all those phenomena which are not proved. Mesmerism would then mean what I have called its magical side, and would embrace those phenomena which are sometimes called the *higher* phenomena of mesmerism. These are of various kinds. It is said, for instance, that one person can, at any time he wishes, mesmerize another who is at a distance, and who is in perfect ignorance of the intentions of the mesmerizer; that a mesmerized person can perceive the thoughts and sensations of the mesmerizer, without receiving any indications from the known organs of sense; that a clairvoyant can see with parts of the body other than the eyes, for example, with the back of the head, or with the pit of the stomach; that a clairvoyant can describe places and persons which he has never read of, or heard of, or seen. Those observers who have done most to elucidate the subject, such as Braid, have failed to observe any of these and other similar higher phenomena. They are unproved. It would be convenient, I say, to include such phenomena only, under the heading of mesmerism; but this I can not yet venture to do. The facts I have to mention I shall call those of hypnotism or mesmerism indifferently. The magical side of the subject may, I think, at present be fairly left out of account.

The primary point in mesmerism is the paralysis of the will; the nervous system is then out of the control of the subject, whether animal or man, and, by appropriate stimulation, any one or more of his nerve-centers can be set in activity. I shall consider first the behavior of the lower animals when mesmerized: in these the phenomena, as far as at present observed, are much simpler than they are in man. If a frog be turned over on its back, it at once regains its normal position; if, however, it be prevented from doing so, and its struggles are for a short time gently suppressed, it becomes hypnotized. Then, although it be left at liberty to regain its normal position, it will not attempt to do so. Apart from the movements it makes in breathing, it lies motionless. If it has been held for a short time only, the hypnotic state does not last long, usually from one to five or ten minutes; but, if the movements it makes, say, at the end of one minute, or of five minutes, and so on, are suppressed, it will not infrequently happen that the frog will then stay without further movement for a considerable time, sometimes even for many hours. During the first part of this time a slight pinch, a sudden flash of light, or a loud noise, will usually cause it to turn over and sit up in its normal manner. For a moment or two it looks a little dull and confused, but rapidly regains its normal activity. During the latter part of this time it responds less and less to external stimuli. When it is in this state, it may be propped up against a support with its legs crossed under it, or placed so that it rests on its head, or placed on its side with its legs arranged in this or that fashion, without offering the least resistance.

I have spoken of the frog as being hypnotized or mesmerized. Let us consider what is meant by this. I think it is obvious that the animal does not remain passive from any astuteness on its part; it is incredible that the frog, finding its efforts to escape ineffective, should make up its mind to remain quiet, and should, although at liberty to move, stay still for hours, becoming more and more determined as time goes on to take no notice of noises, of flashes of light, and of pinching of its skin. On the contrary, it is, I think, obvious that in some way its will has become paralyzed. In order to attempt to explain how this is brought about, we must consider an aspect of reflex action which is very little understood.

A brainless frog will, when its leg is gently pinched, kick out the leg; but, if just previously some other part of the body has also been pinched, one of two opposite things may take place—the leg may be kicked out more quickly and vigorously, or it may not be kicked out at all. In both cases the nerve-center involved in producing the movement of the leg receives an additional impulse from another nerve-center, but in one case the additional impulse increases the activity of the nerve-center involved in the reflex action, in the other case it annuls this activity—there is, to use the physiological term, an *inhibition* of the "reflex" nerve-center.

Inhibition by impulses proceeding from the cortex of the brain occurs every day of our lives. The "will" is perpetually being brought into play to inhibit some nerve-center or other. For example, you may be on the verge of yawning, when it suddenly occurs to you that it will be better not to do so ; you suppress the yawn without moving a muscle. What happens is this : An inhibitory nerve-impulse is sent from the cortex, and puts a stop to the indiscreet activity of a nerve-center elsewhere in the brain. Further, when the cortex is set in activity in a particular way by one impulse, another impulse reaching it may inhibit the first activity, or, in terms of the localization theory, one nerve-center in the cortex may send out inhibitory impulses to any other nerve-center of the cortex.

I need not further multiply instances of inhibition. I wish, however, to lay stress on this, that it is highly probable that impulses traveling from any peripheral nerve-ending to a nerve-center, or from any one nerve-center to any other, may, under certain circumstances, diminish or annul the functional activity of the nerve-center—that is, may inhibit it. And there is equal reason to believe that, under certain other circumstances, the effect produced will not be inhibition, but an increase of activity of the center. The exact conditions which determine whether one effect or the other takes place have not as yet been made out. For the present the facts must suffice us. We may now return to the mesmerized frog.

Whatever the will may be, its action is accompanied by a certain activity of the cortex of the brain ; if this activity is prevented from taking place, the will can no longer act. From the physiological standpoint, then, the mesmerized frog lies motionless because an inhibition of a particular activity of the nerve-cells of the cortex has taken place. We may distinguish two chief causes of this inhibition.

The tactile stimuli sent to the central nervous system when the frog lies on its back are obviously different from those sent when the frog is in its normal position. The unusual nerve-impulses traveling from the skin in the unusual position of the frog are inhibitory nerve-impulses. There is reason to believe that they act first on some lower center of the brain, and that from this impulses are sent which diminish or annul the activity of the cortical nerve-cells which is necessary for the exercise of the will.

The second chief cause of inhibition is in the cortex itself. Handling the frog in the way which is done when it is mesmerized produces a certain emotional condition which we may call fright. But, when the animal is frightened, the nerve-cells of the cortex are set in activity in a special manner. This mode of activity inhibits other modes of activity, and the will is paralyzed.* We can not at present, I think, put in any more definite form the effect of one state of the cortex of the brain upon its other possible states. We do not know enough of the relations of the cortex of the brain to the psychical functions to say more. In some cases fright seems to play a very small part, if

* The term " paralysis of the will " is here used to include the state in which there is an effort of will, but in which the effort is not followed by a dispatch of nervous impulses from the cerebral hemispheres to the lower nervous centers.

any, in producing the effect. That it is not an essential factor is, to some extent, confirmed by the fact that a frog without the cerebral hemispheres can be easily mesmerized; it is difficult to conceive of the animal in this state being very much frightened.

It will be remembered that reflex action from all parts of the body is diminished in the mesmerized frog. After a time, then, there is a marked inhibition of activity of the whole nervous system. Now, in the brainless frog placed on its back there is no such diminution of reflex action; hence in the intact hypnotized frog the spinal cord must be inhibited by impulses coming from the brain; from which we may conclude that centers inhibited in their own proper action nevertheless send out inhibitory impulses to other centers. There appears, then, to be an irradiation of inhibitory impulses, just as we have seen that there is an irradiation of exciting impulses.

Before passing to mesmerism in man I will show you two other instances of hypnotism in the lower animals. The alligator which you see here behaves very much like the frog. It has, however, less tendency to become cataleptic. After a brief struggle, it becomes quiescent and its limbs slowly relax; its mouth may then be opened, and a cork placed between its teeth, without giving rise to any voluntary movement on its part. It may be kept for a considerable time in this limp condition by gently stroking the skin close to its eyes.

So far as I have observed, the hypnotic condition in birds and in lower mammals is not capable of any great development. It may last ten minutes, but rarely longer. In these animals, too, the emotional condition is probably the chief factor in producing the inhibition. Of impulses from peripheral sense-organs, tactile impulses seem to be most effective in the lower mammals, as in the rabbit and Guinea-pig, and visual impulses in the bird. The pigeon which I have here remains longest quiescent when, after it has been held for a minute or two, I bring my hand slowly up and down over its head.

In man the phenomena of mesmerism are of a very much more striking character than they are in the lower animals. Speaking generally, this seems to be due to a greater interdependence of the various parts of the nervous system in the lower animals. In these, when any one center is stirred up by exciting impulses, an irradiation of exciting impulses is apt to take place to all other centers, and the mesmeric state is in consequence apt to be broken. And on the other hand, when a center is inhibited, an irradiation of inhibitory impulses is apt to take place, and the whole nervous system is in consequence apt to be inhibited. Hence the activity or suppression of activity of particular parts of the central nervous system, which forms so conspicuous a feature of mesmerism in man, can be only partially produced in the lower vertebrates. Even in man there is very considerable difference, in different individuals, in the ease with which particular nerve-centers can be excited or inhibited without other centers being similarly affected. But apart from this the fundamental features are the same, whether a man or a frog be mesmerized. The primary point is, as I have said, the paralysis of the will—that is, the inhibition of a certain activity of the nerve-cells of the cortex of the cerebrum.

The great majority of people can not be mesmerized unless they consent to fix their attention on some particular object. This fixing of the attention, speaking generally, seems to be a voluntary exclusion of exciting impulses, leaving thus the inhibitory ones an open field. Idiots, who, on account of the lack of co-ordination of their nerve-centers, can not fix their attention for any length of time on any one object, can not as far as I know be mesmerized. Now this, now that part of the brain becomes active, and exciting impulses are sent out which overpower the inhibitory ones.* Inhibition from impulses arising in the cortex itself are rare unless the patient has been previously mesmerized. Some such cases, however, do occur. But in people who have been previously mesmerized inhibition in this manner is of not unfrequent occurrence; within limits, the more often the changes in the cells accompanying inhibition have been produced, the easier they are to reproduce. Those who have often been mesmerized may fall again into this condition at any moment, if the idea crosses their minds that they are expected to be mesmerized.

Thus, if a sensitive subject be told that the day after to-morrow at half-past nine he will be mesmerized, nothing more need be done; the day after to-morrow at half-past nine he will remember it, and in so doing will mesmerize himself.

An instance sent by M. Richer to Dr. Hake Tuke, presents, it seems to me, an example of inhibition from the cortex which is of a somewhat different class, and more allied to that which occurs in birds and lower mammals. A patient was suspected of stealing some photographs from the hospital, a charge which she indignantly denied. One morning M. Richer found this patient with her hand in the drawer containing the photographs, having already transferred some of them to her pocket. There she remained motionless. She had been mesmerized by the sound of a gong struck in an adjoining ward. Here, probably, the changes in the cortex accompanying the emotion which was aroused by the sudden sound at the moment when she was committing the theft produced a wide-spread inhibition—she was instantaneously mesmerized.

I will show you the method of mesmerizing which is, perhaps, on the whole, most effective; it is very nearly that described by Braid. I have not time to attempt a mesmeric experiment to-night; it is the method only which I wish to show you. With one hand a bright object, such as this faceted piece of glass, is held thus, eight to twelve

* It is said that some persons, while they are sleeping, can be brought by means of passes into the mesmeric state. It would be interesting to observe if this can also be done with insane people.

inches from the subject, so that there is a considerable convergence of the eyes, and rather above the level of the eyes, so that he is obliged to look upward. The subject is told to look steadily at the piece of glass, and to keep his whole attention fixed upon it. This position is kept up for five to ten minutes; during this time the pupils will probably dilate considerably, often assuming a slight rhythmic contraction and dilation; when this is the case, the free hand is moved slowly from the object toward the eyes. If the subject is sensitive, the eyes will usually close with a vibratory motion. In some cases the subject is then unable to open them, and the usual mesmeric phenomena can be obtained. If, when the operator brings his hand near the eyes of the subject, the subject instead of closing them follows the movements of the fingers, the whole proceeding is repeated, but the subject is told to close his eyes when the fingers are brought near them, but to keep them fixed in the same direction as before, and to continue to think of the object and that only. The operator then for some minutes makes "passes," bringing his warm hands over and close to the face of the subject in one direction. When the subject is inclined to pass into the cataleptic state, an indication of his condition may be obtained by gently raising his arm; if he is beginning to be mesmerized, the arm remains in the position in which it is placed. If the arm falls, the mesmeric state may not infrequently be hastened on by telling the subject to keep his arm extended while he is still gazing at the object, or while the passes are being made. And that is the whole of the process. The man thus mesmerized sinks from manhood to a highly complicated piece of machinery. He is a machine which for a time is conscious, and in which ideas can be excited by appropriate stimulation; any one acquainted with the machinery can set it in action.

The distinguishing feature of the earlier stages of mesmerism in man is that by slight stimulation any one center can be easily set in violent activity, and its activity easily stopped, without the activity spreading to other distant centers. It is on this that the mesmeric phenomena usually exhibited depend; with most of these phenomena you are no doubt familiar, so that I need mention one or two only.

Complicated reflexes may be produced in various ways, just as we have seen is the case with a frog even when without its cerebral hemispheres. Thus Braid mentions that on one occasion an old lady who had never danced, and who indeed considered it a sinful pastime, when mesmerized began to dance as soon as a waltz-tune was played.

A statement made to a subject will often produce implicit belief, notwithstanding the evidence of his senses. I remember telling a subject that I was about to bring a hot body near his face, and he was to tell me when it was painful. I put my finger on his cheek, upon which he cried out violently that I was burning him. When he was awakened he remembered that I had touched him with something very hot. The idea I had given him was remembered, the evidence of his sense of touch was disregarded.

There are certain attitudes which we usually assume under the influence of certain moods or ideas; from each of the muscles concerned in bringing about any one attitude, impulses travel up to the brain, and give rise to a definite muscular sensation which comes, therefore, to be associated with a particular mental mood. In mesmerized people the production of a definite muscular sensation not infrequently produces in the mind the mood with which it is, in the wakeful state, associated. At the same time ideas may be produced corresponding to the mood, and the ideas may give rise to particular actions, such as laughing, crying, fighting.

If the head is pushed back and the shoulders opened out, the face assumes a look full of pride or haughtiness, and, if the subject be asked what he is thinking about, he will give some answer indicating what a fine fellow he fancies himself to be. If, then, the head is bowed and the shoulders contracted, the aspect of the face changes to one of humility and pity. Occasionally it happens that a slight pressure on a single muscle, which causes it to contract, will by an irradiation of nerve-impulses produce the muscular sensations proper to a group of muscles, and this will give rise to the associated frame of mind. Thus very different feelings may be made to rapidly succeed one another in the mind of the subject by simply pressing on various muscles of the head and neck. At first sight such an experiment looks like a revival of the now happily forgotten phrenology.

I have said that, in a frog which remains mesmerized for any time, there is a considerable reflex depression—i. e., inhibition of the whole of the central nervous system; that there is an irradiation of inhibitory impulses. In man a similar irradiation of inhibitory impulses appears to take place: usually a mesmerized person if left alone passes gradually, but often rapidly, into a state of torpor; consciousness disappears, memory is lost, reflex action becomes difficult to obtain; finally, it may be, there is complete anæsthesia, a limb may be cut off without producing any movement or any pain. Since this torpor comes on without anything further being done to the subject, we may conclude that here, as in the frog, but to a much more marked degree, there is an irradiation of inhibitory impulses. The primarily inhibited centers send out inhibitory impulses to all other nerve-centers. Up to a certain stage, possibly throughout, any one or more centers may be brought back to a condition of activity by certain exciting stimuli, but when these cease the inexcitable condition is soon brought back by the inhibitory impulses streaming to them from other nerve-centers.

The extent to which the torpid condition develops itself varies in different individuals. It depends upon the condition of the nervous system, upon the relative intensities of the inhibitory and exciting impulses. As far as our present knowledge goes, it would appear that a few only of those who can be mesmerized can be made to pass into a condition of complete anæsthesia. It is possible, however, that this may be due to the passes which give rise to inhibitory impulses not being continued long enough. Dr. Esdaile, who in India was accustomed to mesmerize his patients before performing surgical operations upon them, used to continue the passes for one to two hours, and often to repeat this for several days in succession.

In different people the order in which different centers are inhibited varies, as we should expect, from the unequal development of different centers in different people. This is no doubt of influence in determining whether the general state is cataleptic, somnambulistic, or lethargic, and here probably the method used to mesmerize is also of considerable importance; it would seem that the cataleptic condition is more likely to be developed when the process of mesmerization involves a strain on the eyes of the subject than when he is mesmerized by passes. Not much attention, however, has as yet been directed to this point.

There can, I think, be no doubt that mesmerism may help, and sometimes cure, persons suffering from certain diseases of the nervous system. It is not in our power to make any accurate statement of the way in which this is brought about; but, since disease may be the result of either an over-activity or of an under-activity of any part of the central nervous system, it is reasonable to suppose that a beneficial effect will follow the employment of a method which allows us to diminish or increase these activities as we will. This is a side of the question which is of the greatest interest both to physicians and to physiologists—to physiologists, since it bears directly upon the problem of the influence of the nervous system on nutrition. There is good reason to believe that, by directing attention strongly to any particular part of the body, the nutritive state of that part of the body may be altered. The determination of the actual way in which this is brought about is full of difficulties, but the following way is at least theoretically possible: It may be that the nerve-centers connected with the tissue in question are made unusually active, and that they send out nerve-impulses of a trophic nature, that is, impulses which directly control the nutrition of the tissue. The alteration in the tissue caused by its changed nutritive state—its changed *metabolism*—may conceivably be either beneficial or detrimental to the whole organism; it may give rise to a diseased state, or get rid of an existing one.

The modern miracles of healing, wrought in persons in a state of religious enthusiasm, offer a field for investigating this problem; the field, however, is a particularly bad one, and chiefly because so many people concerned regard any careful examination of the subject as impious. But in mesmerized persons it seems probable that such investigations could be made on a fairly satisfactory basis. Men when mesmerized gradually lose remembrance of those things which they remember when they are awake, but not infrequently other things are remembered which are forgotten in the waking state.* This is normally the case with a person who has been previously and recently mesmerized. He may then remember little else than what took place in the corresponding stage of his previous mesmerization. In a certain state, then, an event or a command will produce in the central nervous system those changes which are necessary for the event or the command to be remembered later, without ever rising to consciousness in the waking condition. Thus, a command to do a particular thing, given to a subject in this mesmeric stage, may be carried out when he awakes, although he is quite unconscious why he does it. We may say that such an act is one of unconscious memory. But it is, I think, something more than this. The subject is usually uneasy and preoccupied until the thing is done ; he is, to a greater or less extent, unable to fix his attention on other things ; he is, in fact, in a state of unconscious attention to an unconscious memory. This brings us to our point. It suggests that if a subject, in a certain stage of mesmerization, be told that in a few days a sore will appear upon his hand, or, conversely, that a sore already there will disappear, the conditions which accompany conscious expectation and attention will, to a certain degree, be established ; and the trophic influence of the nervous system on the tissues may be tested in a manner which puts the experiment fairly within the control of the observer, and, to a certain degree, excludes imposture. Such an experiment has obviously some drawbacks : it would probably only succeed, if it succeeded at all, with a person whose nervous system was in a state of unstable equilibrium ; and it can hardly be expected that the effects would be so striking as when conscious expectation is also concerned. Still, observations of this kind are well worth attention, on account of the medical, the physiological, and the psychological issues involved in the results.

Here I must leave the subject. I have not attempted to give an account of all the phenomena of mesmerism ; I have taken those phenomena which seemed to me to be the least easy to understand, the most liable to misconception, and have attempted to show that they resemble fundamentally certain simpler phenomena which can be observed in lower animals. I have further attempted to string together the various facts upon a thread of theory, which may be briefly summed up as follows :

The primary condition of mesmerism is an inhibition of a particular mode of activity of the cortex of the brain, in consequence of which the will can no longer be made effective.

* A case is recorded by Braid, of a woman who, during natural somnambulism—which is almost identical with a state that can be produced by mesmerism—could repeat correctly long passages from the Hebrew Bible, and from books in other languages, although she had never studied any of these languages, and was quite ignorant of them when she was awake. At length, however, it was discovered that she had learned the passages when she was a girl, by hearing a clergyman with whom she lived read them out aloud.

This inhibition may be brought about by nervous impulses coming from certain sensory nerves, as those of sight, touch, hearing.

It may also be brought about by impulses or changes arising in the cortex itself.

The inhibited cortex, and probably also inhibited lower centers of the brain, send out inhibitory impulses to all other parts of the central nervous system, so that the mesmerized man or animal gradually passes into a state of torpor, or even of complete anæsthesia.

The phenomena of the excitable stage of mesmerism are proximately determined by the possibility of exciting any particular center alone, without exciting at the same time other centers by which its activity is normally controlled. In lower animals this stage is less marked in consequence of a greater interdependence of the various parts of the central nervous system.

I would expressly state that I regard this theory only as provisional. Further, I am quite conscious that it is very imperfect. A complete explanation of the phenomena of mesmerism and of its allied states can only be given when we have a complete knowledge of the structure and functions of all parts of the central nervous system. But I have not much doubt that the explanation of the main features of mesmerism will be found when we are able to answer the question, What is inhibition? And it is some comfort to think that the answer awaits us in the comparatively simple nervous system of the lower animals. I would not be understood to mean that variation of blood-supply and various other events are of no influence in producing mesmeric phenomena; I think, however, that these events are of secondary importance only.

PROTECTION AGAINST LIGHTNING.

II.

IN the year 1875 the Meteorological Society of London was moved to follow the lead of the French meteorologists in reference to lightning-conductors, and to appoint a Lightning-Rod Committee. From the report made to the society by the council in the following year, it appears that the objects contemplated in this action were "an investigation and record of accidents from lightning, an inquiry into the principles involved in the protection of buildings, the diffusion of exact information regarding the best form and arrangement for lightning-conductors, and the consideration of all phenomena connected with atmospheric electricity."* It is obvious that in its first conception this committee was intended to be essentially one of investigation and

* See "Quarterly Journal of the Meteorological Society," vol. iii, p. 75.

inquiry, and it was for this reason appropriately designated a "Permanent Committee." The meteorologists concerned in its inauguration were actuated by the same consideration that was present to the Section of Physics of the Academy of Sciences in Paris when the following paragraph of the instruction of 1854 was drawn up :

> One knows, it is true, a very great number of examples of people being killed or of houses being set on fire; one knows, also, many and diverse instances of metals fused, of timber shattered, of stones and even of walls thrown far away, and many other analogous effects; but what is generally wanting is precise measurements relative to distance, dimensions, the position of the object—both that which is struck and that which escaped. For it is necessary to know what the lightning spares, as well as what it strikes. It is the work of all observers, but especially of officers in the navy and artillery, of engineers, of professors, inventors, and architects, to test these phenomena at the moment they are produced, and to describe them accurately for the benefit of science, as well as that of public economy. Such descriptions, when they refer to a stroke of lightning, should as much as possible point out the track of the lightning from its highest to its lowest point; also they should show, by sufficiently numerous horizontal sections, the relative positions of all objects in a circle wide enough to take in those which have been struck.

In this passage the instruction of the French Academy no doubt touches the one point which is necessary before all else to improve, if not to perfect, the practice of electrical engineering, so far as this is aimed against the destructive powers of lightning. The broad principles upon which the engineer prosecutes his work are happily such as can be referred to actual experiments carried out by the artificial apparatus of the electrician. But there still remain some incidental questions, such as the influence of surface, extent, and form in conductors, the relation of conductivity to tenacity, the area of protection, and the maximum effect of lightning, which can not be settled in this way, and which require an appeal to the larger operations of Nature. This, however, concerns opportunities which can not be arranged at will. The method of the appeal must of necessity be observational rather than experimental. It proceeds upon the lines of close watching and systematic record. Observations where the great operations of Nature are concerned are utterly worthless unless they are made with scientific insight and precision. The plan of investigation that has to be pursued is therefore to collect an exact account of all accidents that occur, and to arrange a system of organization which enables all such chance opportunities to be seized upon and improved by an immediate investigation of concomitant conditions and circumstances. This method of study also must be followed up by patient persistence for a considerable length of time, seeing that accidents from lightning occur at uncertain intervals, and that they are scattered capriciously over the greater part of the surface of the earth. It is for this reason, essentially, that a Lightning-Rod Committee needs to sit in permanence.

The Committee of the Meteorological Society, however, seems very soon to have lost sight of its own excellent design, and to have changed its plan into a mere conference for the preparation of a report, which was drawn up under its auspices and printed and published in 1882, apparently by the conference itself, and which assumes the form of a code of rules for the erection of lightning-conductors, with numerous appendices referring to authorities which had been in some sense consulted. The report is published under the editorship of the secretary, and simply as having been considered and adopted by the delegates of the conference, who seem indeed to have concentrated their attention upon one subordinate object which had been proposed by the Meteorological Society, namely, "the diffusion of exact information regarding the best form and arrangement of lightning-conductors," and to have overlooked entirely the more important work of observation and record which had been contemplated by the society in the first instance, and to which we have drawn attention.

The code of rules put forward by the conference was obviously intended to possess the same kind of authority and position as the "instructions" of the earlier French reports, and indeed its chief value seems to be the approval it accords to the practice of construction which had grown out of those instructions, and which is very generally in use at the present day. It virtually confirms most of the conclusions which had been arrived at by the French commissions.

The "Rules" of the London Conference direct that the main stem of the conductor shall consist of a copper rod or tape, with an ascertained electrical conductivity amounting to ninety per cent of that which pure copper would possess, and weighing six ounces per foot; or that it shall be an iron rod weighing two pounds and a quarter per foot; and that the earth connection shall be made by a copper or iron plate presenting a superficial area of eighteen square feet, imbedded in moist earth, and surrounded with coke. The terminal points are to be more prominent than those usually adopted in England, but they may be less so than the heavy *tiges* of thirty-three feet employed in France. The rod is not to be insulated from the building, but intimately connected with all large masses of metal used incidentally in the construction. All joints in its length are to be imbedded in solder. Curves are not to be made too sharp, and ample provision is to be secured for free expansion and contraction by varying temperature. Water-mains and gas-mains are to be utilized as means of earth contact wherever practicable, and the conducting integrity of the rod is to be tested every year.

A careful perusal of the French instructions, or of Mr. Richard Anderson's very excellent manual upon lightning-conductors, published in 1879, will show that this is substantially an authoritative acceptance of the measures already advised by the best authorities. It is, however, somewhat remarkable that in the report itself of the London Conference nothing whatever is said of the influence of length in reducing the efficacy of a conductor. This is the more strange, because, in speaking of the care required for the formation of joints in the "final decision of the conference on controverted points," the report categorically remarks that bad joints have the same effect as "*lengthening a conductor*," and a reference is incidentally made to one instance, in which a bad joint was found to have had the same effect on a discharge of electricity that the lengthening of a conductor to nineteen hundred miles would have had. This nevertheless was a point that was perfectly understood by the French investigators, and it is obviously one in which the London code is behind its predecessors. In the first French instructions, issued in 1823, there is a paragraph which says:

> Among the conducting bodies there are none, however, which do not oppose *some* resistance to the passage of the electric force; this resistance to the passage, *being repeated in every portion of the conductor, increases with its length*, and may exceed that which would be offered by a worse but shorter conductor. Conductors of small diameter also conduct worse than those of larger diameter.

It follows, as a matter of absolute certainty from this increase of resistance with augmented length, that a conductor which was of ample dimensions for the protection of a building eighty feet high would not be of the same efficacy for a building four hundred feet high. It is for this reason that M. Melsens employed eight main conductors for the Hôtel de Ville at Brussels, and it is for this reason that eight half-inch copper ropes have been carried down from the lantern and cupola in St. Paul's. To use eight main conductors of a given size is obviously, in an electrical sense, the same thing as to use one conductor only of eight times the size.* The practice of the French engineers has hitherto been to double the sectional capacity of the rod for each additional eighty feet of the length that is to be protected by its instrumentality. This practice is a sound one, and certainly should be observed.

There is one other particular in reference to the conference report to which it seems desirable to draw attention on account of the erroneous doctrine to which it may possibly give a sanction. Among the appendices which have been added to the report there is a table, obviously prepared at the cost of some labor, which professes to give the sizes of lightning-conductors recommended by various authorities. In order to facilitate the comparison of the several sizes, all have been reduced to what has been termed the equivalent dimensions of copper. But the oversight has been made, in preparing this table, of treating all cases of galvanized iron as if the zinc in the combination had no other function than the protection of the iron from rust. In reality,

* The solid copper tape which is chiefly used by Mr. Anderson is, to meet the circumstances here alluded to, manufactured of four different sizes, the smallest being $\frac{5}{8}$ inch wide and $\frac{1}{12}$ inch thick, and the largest $1\frac{1}{2}$ inch wide and $\frac{1}{8}$ inch thick.

however, a galvanized iron rod conducts as a combination of iron and zinc, in which the zinc possesses a much higher conducting power than the iron. Zinc surpasses iron in this particular at least three times. All the statements of conductivity that have been drawn from galvanized iron conductors have hence been given much too low. The influence of a too powerful electrical discharge upon a conductor of galvanized iron is, in the first instance, to strip off its coating of zinc by melting this more readily fusible metal. But until this is done the zinc assists very materially in the transmission of the discharge. Practically it is known that galvanized iron ropes effectually transmit discharges which could not be safely carried by ungalvanized ropes of the same diameter. The table is on this account worthless for the purpose for which it was avowedly prepared. It attributes to several of the authorities which are named views on the matter of the size of lightning-conductors which they would certainly not indorse. For instance, Mr. Preece, the eminent electrician, is represented as holding that a copper wire with a sectional area of only the one-hundredth part of a square inch is "sufficient to serve as a lightning-rod for any house." The authority upon which this startling statement is made is a passage in the "Journal of the Society of Telegraph Engineers," in which Mr. Preece says that he thinks "galvanized iron wire one quarter of an inch in diameter is sufficient for the protection of any house." It needs no very large amount of acquaintance with electrical matters to enable the reader to understand that Mr. Preece would not himself have expressed the same confidence in a small copper bell-wire such as is given as the equivalent in the table of the report. Taken in connection with the omission of all reference to the increased resistance in long conductors, it might be inferred from this estimate that Mr. Preece would hold a small copper bell-wire, carried from the golden cross of St. Paul's to the ground, to be a sufficient protection for the great metropolitan cathedral.

In his "Notes et Commentaires sur la Question des Paratonnerres," printed in 1882, Professor Melsens complains that no notice of his system of numerous conductors of weak or small section has been taken in the code of laws of the Lightning-Rod Conference of London, even as a possible alternative of construction, a silence which he interprets as equivalent to a formal condemnation. He says:

Still, I believed that the silence which the conference observes in its code of law upon the possible application of my system was equivalent to a condemnation; I should have been glad to see the conference pronounce, distinctly, without any reticence, either for or against the system as a whole, or in regard to its adoption concurrently with the lightning-rods which it prescribes or which it commends; the eminent *savants* who were a part of it would not have failed in that case to discuss the essentials, with great profit in the elucidation of the scientific and practical question, particularly on the points still subject to discussion, and on which we still meet very opposite opinions. I have to regret deeply, especially in consideration of the ancient *savants* who are members of the English commission, the silence which they have thought it their duty to keep respecting my new system of lightning-rods, while giving the regulations and laws which, according to it, secure the most efficacious protection, aside from all consideration of the constructors who advertise so largely, or who are protected by letters-patent.

The distinguished electrician of Brussels is not without good ground for this complaint, but he may console himself for his disappointment in the approval of his system that has been accorded by other highly competent authorities. In his "Report on Static Electricity and Paratonnerres" at the International Exhibition of Electricity at Paris in 1881, Professor M. E. Rousseau says:

From the comparative examination that I have made, I am convinced that in each of the three constituent parts of which the lightning-conductor is composed, namely, the point, the rod, and the root or earth contact, the system of M. Melsens has a marked superiority over the old system; and, as MM. Angot and Nardi have remarked, must be regarded as efficacious as the old system, if not more so, besides being at the same time less costly.*

M. Angot, the author of an able treatise on "Elementary Physics," printed in Paris in 1881, speaks of Professor Melsens's system of lightning-protection as being "more efficacious, as well as less costly, than the older plan, and sure to come soon into general use." M. Nardi, in a memoir on "The Parafulmine of Melsens," printed at Vicenza in 1881, describes the multiple system of points and rods and the large earth contacts adopted by Professor Melsens as being "the most rational, the most efficacious, the most easy to construct and fix, and the least costly of all the alternative systems of construction." M. Mascart, Professor of Physics in the College of France, in his excellent treatise on "Static Electricity," describes the entire system devised by Professor Melsens as "forming, without any doubt, the most beautiful model of the paratonnerre that has been realized." The frank and outspoken acceptance and praise of France, Italy, and Belgium may, therefore, fairly be placed as a set-off against what Professor Melsens feels to be the discourteous, if not condemnatory, silence of London.

Since the appearance of the report of the Lightning-Rod Conference a small volume has been published by "Major Arthur Parnell, of the Royal Engineers,"† entitled "The Action of Lightning, and the Means of defending Life and Property from its Effects." In this little book the author has been at the pains to compile a reference to a very large number of accidents that have been occasioned by lightning. This, however, has been done for an ulterior and somewhat insidious purpose. He has a new theory of his own to propound, and a revolution in the practice of lightning-rod engineering to propose. He wishes

* Professor Melsens estimates that the cost of effective protection by the old system amounts to very nearly 4¼ francs the square metre, but by his system to only 0·66 of a franc the square metre.

† Now Colonel Parnell.

to do away altogether with the lightning-rod as a dangerous and superfluous expedient, and to establish in its place a system of earth-buried plates and short earth-points surrounding the building. Space does not here permit an allusion to the various fallacies which are involved in this heretical scheme. It will be enough for all practical purposes to say that the proper answer to the dangerous heresy is an appeal to the argument of facts. There are innumerable instances on record in which lightning has been seen to strike lightning-conductors with a luminous flash, and there are still more in which the extremity of the rod bears the traces of the passage through it of lightning; but in every case, if the rod has been of due size and properly constructed and fixed, the building associated with it has been entirely uninjured. The truth obviously is that the question of efficiency and safety entirely hangs upon the amplitude of the dimensions, the number and position of the points, and the completeness of the earth contact, of conductors. In any case where these are insufficient the lightning-rod is a source of danger. In every case where they are ample, and where the system of their establishment is sound, the protection is complete. It will be time enough to enter upon a consideration of the merits of the retrograde course which is advocated in this ill-advised scheme when any single case of failure in a lightning-conductor of satisfactory dimensions, and of tested perfection of construction, has been established before a competent jury on incontrovertible grounds. The failures incident upon defective work—as all unbiased and properly trained thinkers are aware—are among the weightiest of the arguments that tell in favor of the employment of conductors.

In a very large majority of the cases in which accidents have occurred to buildings which have been furnished with lightning-conductors, the mischief has been actually traced by competent inquiry to some easily recognized fault or deficiency of construction. A very instructive illustration of the accuracy of this remark has quite recently presented itself in a form which is worthy of notice. Shortly after midnight, on the 26th of November, during a thunder-storm of some severity, a flash of lightning struck the lightning-conductor attached to the spire of Chichester Cathedral, and scattered a considerable portion of it into fragments. A letter from "A Fellow of the Royal Astronomical Society" forthwith appeared in the "English Mechanic and World of Science," drawing attention to the accident, and commenting upon it in the following words: "This seems to open a very serious question indeed, because, if so elaborate an affair as the Chichester conductor proved so much worse than useless when a thunder-storm came, what security have we that a similar disaster may not befall at, say, the Government magazines at Purfleet or elsewhere?" In reference to the accident which called forth this note of alarm, it may be at once, however, said that it belonged essentially to the class of occurrences which have been pointed at in the beginning of this paragraph.

The conductor which was attached to the spire was not adequate and competent for the protective work which it was intended to perform. It had been put up sixteen years ago, when a new spire was erected in the place of the old one, which fell in consequence of having been added as an after-thought to a tower that had not been prepared to bear its weight, and was of a form which is, happily, now obsolete. It originally consisted of twelve No. 15 gauge* copper wires arranged in a double series, side by side, and held together by a double strand of zinc and copper wire crossing them transversely, and acting as a kind of weft to the longitudinal copper warp. The conductor was thus a sort of ribbon of copper wire, with transverse binding-threads of zinc. The weight of the metal in this compound conductor was ten and a quarter ounces per yard, instead of being thirty-six ounces per yard, as it ought to have been at the very least if it had fulfilled the conditions that are now required for such a task as it had been required to perform. But, besides this, in consequence of having been exposed for sixteen years in its sub-littoral situation to the blasts of the moist sea-wind, the copper wires were in many places eaten into by corrosive action where the zinc wire of the woof crossed them, so as to reduce to some considerable extent their original conducting capacity. The conductor was so fixed that it descended from the summit of the spire along the slope, and along the face of the tower, then crossed the lead flashing of the roof, passed down the main wall of the building near the intersection of one of the transepts with the nave, and was finally plunged into a well dug into the grave-yard about twenty feet from the place where it reached the ground. At the time of the storm a flash of light was seen to pass along the upper part of the track of the conductor, and this flash was accompanied by an instantaneous crash of thunder, that awoke most of the slumbering inhabitants of the close. The destruction of the conductor, however, was not discovered until the second morning after the storm, when some shattered fragment was observed projecting from the tower. It was then found that about forty feet of the conductor at the top of the spire still remained uninjured in its place, but that for the next one hundred feet below this the woven metallic band had been scattered into a shower of short fragments of copper wire, which were strewed thickly upon the roof of the tower and of the lower building. These fragments were three quarters of an inch long, corresponded in length with the materials of the transverse crossings of the zinc wire, and bore unmistakable indications of galvanic corrosion upon their ends. The lower portion of the conductor was uninjured, but one of the iron rain-pipes, which descended from the roof of the transept a few feet away, had been shattered by the discharge. It was therefore manifest that from the leaden covering of the roof downward the incompetent conductor had been assisted in its work by the roof and

* That is, of one sixteenth of an inch in diameter.

its numerous iron rain-pipes, and this intelligibly accounted for its own preservation through that portion of its course; and it was also clear that the earth communication of the conductor was not ample enough for the transmission of the entire discharge, as, if it had been, the lower part of the conductor would have been shattered like the upper part, and the rain-pipe would have remained uninjured. The resistance of the earth communication of the conductor, measured through the uninjured fragment, was sixty-five ohms—that is, some twelve or sixteen times greater than under any circumstances it ought to have been. So far, therefore, from this maligned conductor being open to reproach, it had done exactly what it was scientifically bound to do, and what any expert could have foretold that it would do, under the circumstances which have been described.

But the critic who sounded the note of alarm in "The English Mechanic" was also egregiously wrong in another by no means unimportant particular. The unfairly maligned conductor had not "proved worse than useless when a thunder-storm came." As some more appreciative commentator figuratively but not inaptly remarked at the time, it had "gallantly died at its post in the efficient performance of its duty." Although the lightning-conductor was destroyed, the exceedingly beautiful stone spire remained absolutely uninjured. It had not even a scar upon its face. This circumstance of the destruction of a lightning-rod of too narrow capacity without injury to the building to which it is attached is by no means of infrequent occurrence. About five inches of the top of the second conductor which Franklin himself erected in Philadelphia were destroyed by a discharge, which was seen to strike the rod, and which also made itself visible in a luminous blaze in the dry earth around its base; and Franklin adroitly claimed the incident as a proof that Nature itself had borne testimony in favor of his invention. The brass-wire conductor of the war-ship Jupiter was struck at sea on June 13, 1854, and the sixty brass wires of which it was composed were shattered into fragments the size of a pin. But no injury was done to the vessel. A large number of instances of a kind very similar to this well-known and altogether typical case might be adduced did space permit. But it must not therefore be inferred that so desirable a result is in the proper order of events. When a lightning-rod "dies at its post" in a successful defense, as in the memorable Chichester case, the auspicious issue is due to the accidental circumstance that no better extraneous earth contact is within the striking reach of the discharge. If this were the case, the lightning would certainly be diverted from the course of the conductor into the more facile way, and, in making its devious leap into the more available path, would be quite sure to leave the marks of its divergent passage in some undesirable form. It is on this account, as well as because of the wasteful outlay which is required to supply a new rod when an old one has been destroyed, that lightning-conductors of insufficient dimensions, and of bad principles of construction, are by no means to be looked upon with tolerance, to say nothing of favor, notwithstanding the occasional good service that may be entered to their account.

Irrespective of all theoretical considerations, and upon purely experimental and demonstrative grounds, it is possible in the present state of electrical science to definitely state what it is that an electrical engineer has to do when he undertakes to protect buildings against the destructive force of lightning. He has, in the first place, to make sure that, wherever the lightning can fall, it shall find an open and practically unobstructed path to traverse in its passage to the ground. He is quite sure that the electric discharge will confine itself to the track of a conductor, and will pass quietly and harmlessly along it, provided its dimensions are adequate to the task of transmission, and provided the inlets and outlets are sufficiently capacious for its unimpeded reception and escape. It is a thoroughly established and altogether indisputable canon of electrical science that when a discharge has to pass through a conductor of too narrow size, and with obstructed inlets and outlets, it, of necessity, accomplishes its passage as a turbulent and ill-regulated force all the way, with a tendency at every step to make a devious outburst or overflow ; and that when it passes through a conductor of ample dimensions, and with unimpeded ingress and egress, it is devoid of all erratic impulse, and traverses the appointed channel as an obedient and well-trained power. The task of the engineer, therefore, resolves itself primarily into so arranging his apparatus as to keep the lightning in its well-ordered and harmless state so long as it is in the close neighborhood of buildings that might be injured by any uncontrolled outburst through a devious path. There are three ways in which he can seek to accomplish this purpose. He can multiply and, as it were, enlarge the gates of ingress by increasing the number of his air-terminals and earth contacts through which the discharge may have to be gathered into the conductor. He can augment the dimensions and the carrying capacity of the conductor, and he can amplify the outlets of escape, whether in the direction of the cloud or earth. Where these conditions have been properly secured, there is not the most remote probability that the conductor will fail in its appointed task. This is not a question that is now open to doubt. It is as certain that the lightning will traverse a well-arranged and competent conductor, rather than the building to which this is attached, as it is that the electric spark from the charged conductor of an electrical machine will strike a brass ball and rod, and will not strike a stick of sealing-wax or of dry wood, when these are presented side by side. As a matter of fact it is sometimes imperfectly insulated tracts of the surface of the earth that are inductively charged by the propinquity of an overhanging storm-cloud, and sometimes the overhanging cloud that is inductively charged by disturbances originating in the ground. But the conductor provided by the electrical engineer acts in precisely the same way, and with equal efficiency, in either case. It provides the means by which the electrical disturbance may set itself at rest in a quiet and unexplosive way. The chief danger that has to be feared is the purely economical one that there is always a tendency on the part of the imperfectly informed public to limit too narrowly the cost, and in that way to impair the efficacy, of the engineer's work. The duty of the engineer is, summarily, to see that his building is adequately covered above by the lines of the conducting network, that the main channel of his conductor is ample for any storm overflow that it can, by any possibility, be called upon to accommodate, and that the outlet to the earth is capacious and free. Even in the present state of electrical science it can, with the utmost confidence, be affirmed, not only that wherever destructive accidents have occurred in association with lightning-conductors, such accidents have, in every case, been due to the circumstance that the conductors have been of faulty construction, but also that in by far the greater number of instances the fault has been in the least conspicuous and least obvious part of the apparatus, where the earth contact has to be established. In his report on the lightning-conductors of the Paris International Exhibition, Professor Rousseau states that it is in this particular that lightning-rods most generally and most flagrantly fail. In one passage of the report he says:

> I do not know whether I have defined with sufficient precision what is implied in a good communication with the earth, but I think the principle, at any rate, may be laid down that the communication of a lightning-conductor with the earth can not be considered good if it is inferior to that of any masses of metal that lie in its close neighborhood. If this is the case, it may be anticipated, as has so frequently been found, that the lightning will quit the paratonnerre to pass to the object which is in better communication with the earth. It is thus that buildings have been frequently set fire to by lightning which has leaped from paratonnerres to gas-pipes. In one notable case, after striking the conductor of a church in New Haven, United States, the lightning left the conductor to pierce a brick wall fifty centimetres (nearly twenty inches) thick, to get at a gas-pipe which rose twenty feet out of the ground a little distance off.

We ourselves some little time ago investigated the nature of an accident occasioned by lightning, which so strikingly confirms the views expressed by Professor Rousseau that it is worthy of being specifically brought under notice here. In the year 1865 the tower of the church of All Saints, in Nottingham, was struck by lightning during a severe thunder-storm. The tower was one hundred and fifty feet high, and had a small rope of copper wire, intended to serve as a lightning-conductor, descending along its west face from one of its corner pinnacles to the ground, where the rope terminated by being coiled round a stone buried a few inches in the dry soil. On the inner face of the same wall of the tower, near its base, and only separated from the conductor by a solid stone wall four feet six inches thick, there was fixed a gas-standard of iron, which was used in lighting the church. The lightning in its descent left the conductor at this point, and passed through the solid mass of masonry, to reach the standard, knocking out a large circular breach in the stone-work by the way. It preferred to take this devious path, and to avail itself of the facilities which the capacious gas-main connections of the town afforded it for the accomplishment of its escape into the earth, rather than to embarrass itself with the still more onerous task of forcing its way into the dry soil at the bottom of the tower, through the too briefly terminated coil of the rope. The floor and pews of the church were found to be on fire the day after the storm, and some considerable mischief was done before the conflagration could be stopped. This fire was almost certainly due to the circumstance that the gas-pipe from the standard was connected with the meter and the mains by means of a short length of soft fusible gas-pipe in a small basement-room under the floor of the church. But, when an investigation into the cause of the fire was subsequently instituted, no one seemed to be able to say whether an escape of gas from the injured pipe had been lit up at the time of the lightning-discharge, or whether the actual lighting of the gas was due to some subsequent introduction of a burning flame into the neighborhood of the gas-meter.

The obvious method of guarding against accidents of this class is the simple expedient, wherever gas-pipes are concerned, of connecting the termination of the conductor directly, by means of a sufficiently ample metallic band, with one of the large iron pipes of the general system of the mains. If this had been done with the lower extremity of the rope, in the case of the tower of All Saints Church, instead of merely twisting it around a stone in the dry surface-soil, the injury to the wall at the bottom of the tower, and the consequent train of accidents which culminated in the burning of the floor of the church, would have been physically impossible. The lightning would then have gone through the large, open, and direct route to the mains instead of piercing a stone wall four feet six inches thick, and leaping across a small fusible gas-pipe to get there.

The case is precisely of the same nature as the accidents alluded to by Professor Rousseau. The earth communication of the copper rope being inferior to that of the neighboring gas-pipe, the lightning quitted the rope to get at the ground through the pipe. No more striking and instructive illustration of the danger of insufficient earth contacts could possibly be furnished.

A still more curious illustration of a somewhat similar kind occurred at Chichester, simultaneously with the destruction of the lightning-rod which has been already alluded to. The boundary of the cathedral close in one direction is marked by a tall and stout iron rail, which divides its precincts from the main street of the town. On the side of this street which is opposite to the cathedral stands the Dolphin, the principal hotel of the city. About an hour after the accident, and while the inmates of the hotel who had been startled by the lightning and thunder were still awake, and in some alarm, a smell of fire was perceived to be pervading the house. The landlord at once rose and proceeded to investigate the cause, and was led by the odor of burning wood to one of the cellars in the basement, where he found the small gas-pipe fixed to furnish it with light melted for several inches, a large flame issuing from the improvised gap, and a beam of wood a little above the blaze already on fire. A thorough and exhaustive examination of the place at the time, and afterward, revealed no trace anywhere else of the passage of the lightning. A water-pipe running in from the outside main, however, transversely crossed, and almost touched, the gas-pipe as this descended from the ceiling to the bracket, and just where the gap had been made. The popular notion among the servants of the hotel was that the lightning had come in through some open cracks in the cellar-door from the pavement of the street, that it had run along the water-pipe, and that it had cut through the gas-pipe as it passed across. The more scientific explanation of the insidious invasion by fire, in the dead of the night, no doubt is that, when the discharge of lightning issued from the cloud to the earth, it had scattered itself in various directions, using such stepping-stones by the way as offered in its path. One part of the discharge, then, first seizing upon the gas-pipes connected with the street lamps, took a course through them to reach the earth, but, coming opportunely by the way across the water-pipe in the cellar of the hotel, transferred itself to that pipe on account of the greater facilities that were offered by it for making an easy and good earth contact through the largely expanded subterranean mains, but "sparked" as it passed from pipe to pipe, and in doing so opened a breach in the small fusible metal wire, and lit the gas as it began to escape. The flame then enlarged the breach by melting a considerable portion of the pipe, and was making good progress toward burning down the house, when its mischievous proceedings were happily discovered, and arrested in the manner which has been described.

The telegraph-wire which, according to the opinion of Mr. Preece, may be sufficient for the protection of any house, is also, it must be remembered, capable of acting as a source of very considerable danger in circumstances that are by no means unfrequently encountered in the arrangements of every-day life. At the time of thunder-storms, portions of the electrical discharge are apt to be conveyed into the interior of buildings by telegraph and telephone wires that are distributed to them for the service of signaling-instruments, and may possibly set fire to badly conducting and inflammable substances that chance to be in connection with them. Instances of this form of accident are now often met with, especially in situations where telegraph-wires are carried to outlying post-offices over high and exposed tracts of land. In such cases it is, most generally, not the full force of the lightning-discharge which effects the mischief, but the partial and secondary discharges which take place in consequence of the influence of induction. The long stretch of insulated wire, having been inductively charged by the near approach of some storm-cloud, sympathetically discharges itself of its accumulated force when the tension of the cloud is relieved by an outburst of lightning in some other direction. The shocks occasionally experienced by telegraph-clerks when handling their instruments during the prevalence of thunder-storms in the neighborhood are due to this cause. It sometimes happens, however, that an actual discharge of lightning does involve a telegraph-wire, and such discharge is then usually distributed so that it passes to the earth in small, broken outbursts wherever it can find an outlet. In such instances enough of the fragmentary discharge may fall to the share of some signaling-office to produce very grave mischief. Telegraph-wires should, on this account, never be carried into the interior of dwelling-houses, or of inhabited places, without appropriate arrangements having been made to neutralize the risk. The plan which is most usually adopted for the protection of instruments and operators in such circumstances consists in the ingenious expedient of arranging two broad metal plates so that their contiguous surfaces be face to face a very small distance apart, one of the plates being in immediate connection with the telegraph-wire, while the other is in communication with the ground. The narrow interval between the two plates is then sufficient to prevent any escape of the ordinary electrical current of low intensity which is employed in telegraph work, but upon the occasion of the wire becoming accidentally charged with an electrical force of high intensity, such as is produced by the agency of the thunder-cloud, this leaps through the narrow space by virtue of its superior explosive power, and so escapes harmlessly to the earth, instead of making its way through some more devious and dangerous route. The plates are, of course, designedly fixed where they serve to intercept the discharge by the temptation of the more open and free passage to the earth, and in that way divert it from the dangerous course which it would otherwise pursue.

The best course for the electrical engineer, who is planning the protection of any building against lightning is, therefore, on account of the various considerations which have been urged, to begin with the arrangement of that which is the primary essential, the earth contact. In towns where there is a large system of water-supply and gas distribution at hand, this is generally an easy task. But it by no means follows that, where the main pipes of water and gas supplies are not available, a square yard of sheet-copper or iron, buried in the ground, can in all cases be accepted as a satisfactory earth connection. It certainly would not have been so in the instance of All Saints Church.

In the circumstances which have been described in speaking of the accident there, a yard-square earth-plate could not have been depended upon to prevent the mischief. The lightning would still have preferred the largely developed root of the gas-mains to any such puny substitute, although such an earth-plate, well bedded in moist ground, might have served all purposes in the absence of so formidable a competitor. The condition of safety is that which has been so well stated by Professor Rousseau. The communication of the conductor with the earth must not be inferior to that of any neighboring mass of metal. When the arrangement for the earth connection has been efficiently settled, the conductor may be carried up from it, and this may with equal assurance be done either upon the single-rod system of Gay-Lussac or upon the multiple-rod principle of Professor Melsens, so long as the building is of moderate size and of a compact form. But, if the building is of large dimensions and of irregular form, the single conductor would of necessity have to assume an approximation to the multiple type, as the main stem is branched out above to bring every gable and turret and pinnacle of the structure under its protection. It is only when it has been completed by a broadly cast net of metallic meshes and lines that the old early dogma of the protected area can be now allowed to survive even in the mind of the engineer. When the work of construction has been so far carried out it is still, however, not to be looked upon as complete until the stamp of efficiency has been placed upon it by the application of the final test, which the advance of electrical science has now placed in the hands of the constructor. It is the crowning distinction of this system of defense that by a very easy process it can be at once ascertained whether all the arrangements of the engineer have been properly carried out. By the employment of the ingenious piece of apparatus which is known as the "Differential Galvanometer," the electrician can in a few minutes ascertain what the resistance is that would be offered between the air-terminal and the earth communication of a conductor, if a discharge of lightning fell upon the rod. That resistance must never be left unheeded if it amounts to anything in excess of the quantity which is technically known as two ohms. It is quite possible, indeed, by the exercise of judgment and skill, to reduce the resistance in every case somewhat below that. With a conductor which has recently been erected upon the Hall of General Assembly in Edinburgh, it was found at the final test that the earth resistance was only the 0·7 of an ohm. But the galvanometer test must not only be applied as the last step of the construction; it must also be drawn upon from time to time, and at not too distant intervals, to ascertain how far the originally well-conceived and well-executed work is or is not in process of being injuriously affected by the physical agencies that are at all times in antagonistic operation to the constructive efforts of man. The free and frequent use of the testing galvanometer is, indeed, the natural consummation of the beneficent work which was initiated by Franklin one hundred and thirty years ago. Without this instrument the lightning-conductor is a hopeful and very generally helpful expedient. But, with the galvanometer, it is now assuredly competent to take rank as a never-failing protection.—*Edinburgh Review.*

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

Closing Remarks.

It remains only now that I should consider the general conclusions toward which our discussion of the subject of happiness as a guide to conduct may appear to have led us.

Let me note, yet once more, that those have entirely misapprehended the whole drift of this series of papers who imagine, as many still seem to do, that my subject has been the morality of being happy, the propriety of seeking after happiness. The mistake appears so absurd, when the nature of the reasoning I have advanced is considered, that it would seem hardly worth while to correct it, seeing that no one who could fall into such a mistake could (one would imagine) in the least profit by any explanation or correction. Yet the mistake has been made by several who are clearly not devoid of capacity alike to render and to receive a reason. I have, therefore, felt bound to correct it as far as possible, and, as several letters recently received show that the error is still entertained, I have now to correct it afresh. Let me explain, then, that the object of these papers has been to show what sort of moral law is likely to arise, and what law appears actually to have arisen and to be in progress of formation, when the guide of conduct is the increase of happiness—individual happiness, and the happiness of those around us, with due regard to the proper apportionment of altruistic and egoistic happiness. I have not examined such questions as, What is happiness? What kind of happiness is worthiest? and so forth. I have taken, as included in the term "happiness," all the various forms of pleasurable emotion of which the human race is susceptible, while all the various forms of painful emotion to which we are exposed have come naturally into consideration as all involving greater or less diminution of happiness. With the development of the human race, or of any part of the human race, in one direction or in another (for development is multiform), we find that ideas about pleasure and pain become modified in various ways. And it has been a special part of our subject to consider how the lower forms of pleasure, those related first to the physical gratification of self, and next those related specially to self but otherwise of higher type, give place gradually to the higher gratifications arising from altruistic relations. But, apart from such considerations, our whole inquiry has been into the development of conduct by the natural operation of those laws which influence the development of happiness.

In passing I would, however, note that the law of conduct thus considered is by no means that abstraction which has been called "the happiness of the greater number," according to which each person is to regard himself and to be regarded as one, while the rest, being many, are to be regarded as of very much greater importance. This abstraction has not and never had any value whatever, as a rule of conduct, either in a man's self or in his relation to others. Even if we can adopt any meaning for the word happiness as thus used, it will be found that no rational way of apportioning the happiness thus regarded as a sort of common property, can be conceived. If the law instead of being an abstraction were real and could be definitely applied, it could result only in this, that each person, being but one, should utterly neglect his individual welfare in favor of the general happiness, and, as it can be readily seen that no benefits he might receive from those around him (obeying, we may assume, the same law) could possibly compensate for the direct and immediate effects of this complete self-abnegation, it follows that a community of persons obeying this law would be a community of miserable beings; so that obedience to this law for obtaining general happiness would in reality insure universal misery.

Taking concrete instead of abstract happiness as the guide of conduct, were cognize far different results. We see that, though there must of necessity be a compromise between egoistic satisfactions and altruistic cares, the compromise need by no means imply antagonism. Regard for the welfare of others, though in its inception more or less of an effort, becomes more and more spontaneous as social relations develop. After spontaneity has been attained, altruistic actions involve more and more of egoistic satisfaction. Conversely, the care of self, which in the earlier stages of social development appears to involve more or less of disregard for the interests of others, becomes more and more altruistic in its effect as society advances. Thus also we recognize the answer to what at first might seem a difficulty, viz., that with the improvement of social relations the opportunity for altruistic actions might seem likely to steadily diminish. We see that the domain available for altruistic actions changes in position rather than in extent; nay, that such change of extent as actually accrues is toward increase. In a society where, owing to the steady improvement of the relation between egoistic and altruistic interests, the number of those depending for their happiness or even for their existence on altruistic cares has steadily diminished, the number of those who are the subject of altruistic emotions will as steadily have increased. Sympathy becomes more widely extended, its development becomes surer and more rapid, as its operation becomes more pleasurable, and a change of this sort can not but take place as occasions for directly altruistic actions, such as arise out of pain and suffering, become less frequent.

With increased spontaneity in altruistic actions, more pleasurable feelings in the discharge of altruistic duties, and a wider range for altruistic emotions, will inevitably come such an evolution of conduct as must tend greatly to increase the well-being of the community. The care of self will be felt as a duty to others; due care of others will become a source of gratification to self. Society will be simply, on an enlarged scale and in a more varied form, such a community as might be formed by a number of kindly, well-meaning persons, of good capacity and pleasing manners, brought together for purposes of travel, research, or pleasure. In such a community it would be felt that each person's first duty was to take due care of self, first as just to himself, and secondly (yet chiefly) as a duty to the rest of the community. But it would also be felt by each member of such a community that he must be careful of the interests of others, ready to be of use to any other members of the community who required assistance such as he could give individually, or to combine with others where the assistance of several might seem to be required. Picture the relations of such a community, all of good-will, kindly, and anxious that the business of the community should go on so as to give pleasure to all, and it will be at once seen how little there is of actual selfishness in due care of self, how such care may be, nay, must be, a duty owed to all the rest; while, on the other hand, it will become clear also how each member of such a community is interested in the existence among all of a kindly interest on the part of each in the well-being of the rest. The social body, whether we consider the family, or the gathering of families into communities, or the collection of communities into nations, or the multitude of nations which form the population of the earth, may be regarded as an aggregate which should be pervaded by such ideas as are found essential for the comfort and happiness of gatherings casually brought together. The due subordination of self to others in certain relations, and of others to self in relations not less important, which is found in all such gatherings on a small scale and of comparatively uniform character—as in the passengers on an ocean-steamship, the members of a company of travelers, the fellows of a scientific expedition, or even a pleasure-party—is what is necessary for the well-being of the body social; and out of this necessity, instinctively recognized, and exercising its influence steadily in the process of the evolution of races, nations, and the human family as a whole, seem to have sprung all those duties between man and man, between race and race, and between nation and nation, which form the present code of social morals, and will hereafter—developed and improved—form the moral code of perfected man. "What now, in even the highest natures," as the great teacher of our day says, "is occasional and feeble may be expected with further evolution to become habitual and strong; and what now characterizes the exceptionally high may be expected eventually to characterize all. For that which the best human nature is capable of is within the reach of human nature at large."

"That these conclusions," Mr. Spencer goes on to say, "will meet with any considerable acceptance is improbable. Neither with current ideas nor with current sentiments are they sufficiently congruous. Such a view will not be agreeable to those who lament the spreading disbelief in eternal damnation; nor to those who follow the apostle of brute force in thinking that because the rule of the strong hand was once good it is good for all time; nor to those whose reverence for one who told them to put up the sword is shown by using the sword to spread his doctrine among heathens." From ten thousand teachers of a religion of love who are silent when a nation is moved by the religion of hate will come no sign of assent; nor from those priestly lawgivers who, "far from urging the extreme precept of the Master they pretend to follow, to turn the other cheek when one is smitten, vote for acting on the principle, Strike lest ye be struck. Nor will any approval be felt by legislators who, after praying to be forgiven their trespasses as they forgive the trespasses of others, forthwith decide to attack those who have not trespassed against them. But though men who profess Christianity and practice Paganism can feel no sympathy with such a view, there are some, classed as antagonists to the current creed, who may not think it absurd to believe that a rationalized version of its ethical principles will eventually be acted upon."

Finally, I would ask those who have followed me thus far to note how all the duties we have considered, both egoistic duties and altruistic ones, may be seen with advantage from a different point of view and in a changed aspect, though unchanged in reality. We are in the habit of regarding the study of moral laws always from the personal side, and nearly all teachers in such matters (one might almost say all) view the subject in this way, since, even when laying down a code of morals, they present each law as it appeals to the reason and should affect the conduct of the individual. But it should be remembered that a moral law which commends to each man a particular line of conduct, is a law which, if accepted and followed by all, influences each man by the effect it produces on all the rest. Thus, a rule of conduct seemingly egoistic, and really egoistic as affecting the individual, becomes, in any society which accepts and obeys it, purely altruistic in its effect; while, *per contra*, a law seemingly altruistic in terms becomes purely egoistic in influence. If, instead of indicating a due regard for self and a proper subordination of self to others, our study of the morality of happiness had indicated as best for the community a series of duties directed solely to the benefit of self, yet the adoption of such a moral code by all men would be altogether unselfish, seeing that it would mean the forsaking of all right or title to help or sympathy from others; and others are many, while self is but one. If, on the other hand, we had found a system of perfect altruism commending itself as best, the acceptance of such a system would be no sacrificing of self to others, but would mean the acceptance of the principle that every one else was bound to assist in all his ways and wishes the accepter of this seemingly altruistic code—to sympathize with him in all his sorrows, and to care for him far more than for themselves. We have not been led to recognize any such abnegation of self on the one hand, or regard for self alone on the other hand, as desirable; but, in such degree as we have seen a regard for self to be desirable, we have in reality been led to the recognition of the rights of others (since each self is another to all others), while, in such degree as we have seen that each should consider not only the rights but the requirements of others, we have been led in reality to the recognition of the rights of each man to the assistance and sympathy of his fellows.

THE CHOLERA-GERM.

By E. K.

AT the present moment, when the Continent has again become the battle-field between cholera and the human race, all questions concerning the cause, diffusion, and prevention of the cholera-virus must take a prominent place in the deliberation on the best sanitary measures to be adopted in combating this insidious foe. Almost all practical preventive measures in this country and on the Continent as regards cholera and other infectious maladies are based on the assumption—supported by a good deal of evidence both theoretical and practical—that the virus is particulate, and, as indicated by its self-multiplication within the affected person, is a living organism. But the nature of this supposed organism of cholera has, until quite recently, been altogether mysterious. As is well known, Professor Koch and colleagues, sent out last year by the German Government to investigate the cholera in Egypt and India, have ascertained that in the rice-water stools voided by patients suffering from the disease there are present, besides micrococci and bacilli, common to the evacuations of other than cholera patients, peculiar curved bacteria, so-called "comma-shaped" bacilli, which Koch has not been able to discover in any cases of diarrhœa. These "comma-shaped" bacilli Koch has succeeded in isolating by artificial culture. Unfortunately, cholera has hitherto not been found transmissible to the lower animals, and therefore the function of these "comma-shaped" bacilli must at present remain unknown. All we can therefore say is that Koch has shown that in cholera evacuations there exist, besides micrococci and straight bacilli, other organisms also characterized by this—that they are curved or comma-shaped. Whatever else has been said by Koch, his followers, and critics, scientific and daily papers, as to these "comma-shaped" bacilli being the cause of cholera, is simply and purely a supposition, which, as we shall presently show, is wanting in the most essential elements.

First and foremost, Koch has been unable to find anything of this "comma-shaped" bacillus in the blood or tissues in any stage of cholera. Now, all experience on cholera teaches that, whatever its cause may be, the alimentary canal is not the only passage through which the cholera-poison enters the system, but that its entrance through the respiratory organs is also an established fact. For this reason it is necessary to assume that, as in other infectious diseases, it passes through the blood and system in the stage of incubation of the disease. The symptoms of cholera, the whole nature of the disease, shows that it is not a local distemper of the alimentary canal, but that the latter is merely a symptom of the malady, as much as in typhoid fever the distemper of the ileum and spleen, or in scarlatina that of the skin, throat, and kidney. Had Koch found the "comma-shaped" bacillus in the blood or the tissues, e. g., the blood-vessels of the alimentary canal, mesenteric glands and spleen, the nature of this "comma-shaped" bacillus would have been as obscure as ever, but still there would have been some sure element in the chain of surmises. Of course it might be argued, and as a matter of fact it is argued by Koch in the reports to his Government, that the bacillus, having found entrance into the cavity of the intestines, there multiplies, and produces some ferment, which, absorbed into the system, sets up the whole chain of appearances constituting the symptoms of cholera. This is quite possible, and, to a certain limited extent, is borne out by experience, notably in the case of putrid or pyæmic poisoning, where, owing to the presence of putrefaction in a wound, the products of putrefaction—the sepsin—absorbed in sufficient quantities into the system, create the above disease, often terminating fatally. In this case no specific organisms are detected in the blood or tissues; their presence is limited to the wound only, and their effect is merely this, that some ferment—ptomaïne or some other substance—produced by them is absorbed into the system.

That this should also be the case in cholera is, as we just said, possible, but it is not probable, for the simple reason that the cholera-virus in a large percentage of cases enters the system by the respiratory organs, and therefore it must be assumed in these instances to pass into the general circulation, and consequently, if it is to be identified, must be identified in the blood or tissues.

The practical consequences of an assumption that the cholera-virus passes into the system exclusively by the alimentary canal, and that it has its breeding-ground in the latter only, are so great, that before acting on such an assumption the basis for it ought to be established, which it certainly is not.

Secondly, is it a well-established fact that this "comma-shaped" bacillus is present only in cholera evacuations? If it should be found that this bacillus is absent from the alimentary canal in all other diseases, then we could at best recognize it as pathognomonic, but it by no means follows that it is also pathogenetic.

I have lately had the opportunity of inspecting this "comma-shaped" bacillus in specimens prepared by Koch, from the rice-water evacuations, and also in artificial cultures, and I have fully convinced myself of its reality. But I possess prepared specimens of evacuations of patients suffering from severe diarrhœa (in an epidemic outbreak of diarrhœa in adults in Cornwall in the autumn of 1883, and investigated by Dr. Ballard, Inspector to the Local Government Board), in which specimens, besides micrococci and straight bacilli, there are undoubtedly present bacteria which, in shape and size and mode of staining, so closely resemble the "comma-shaped" bacilli of cholera that I am unable to discover a difference between them. I have, however, not made any artificial cultivation of them, and therefore can not say whether there exist any differences between the two, notably as regards their mode of growth.

Here is one other point to which we wish to draw attention: as Cohn ("Beiträge zur Biologie der Pflanzen," Heft ii) has shown, and as is now generally accepted, a rod bacterium which is characterized by being curved is regarded not as a bacillus but as a vibrio; and it is not quite clear why, unless for the sake of novelty, Koch, generally accepting Cohn's terminology, should in the case of the cholera bacterium have deviated from it, and should not rather have spoken of it as a vibrio, because a vibrio, and particularly a *Vibrio rugula* (sp. Cohn), is the organism which he describes as a "comma-shaped" bacillus.—*Nature.*

CURIOUS FUNERAL CEREMONIES.

AMONG the most striking features of the popular life and thought which the student of the different races of mankind has to consider are the ideas and usages that are grouped around death. The fact of death, on account of its absolute certainty as well as on account of its nature, is the incident of human existence that has struck all peoples with the most solemn impressiveness. If there are any races who appear indifferent to death, it will most probably be found on examination that their feeling is not the natural one, but the resultant of modifications that have been impressed upon it by some feature of their religious system or under the influence of peculiar ideas of duty and virtue. The ancient Egyptians, so far as their monuments have revealed them to us, lived in constant view of death, and made the preparation for it, both for the care of their bodies and the salvation of their souls, the most important work of their lives. No other people seem to have paid so paramount attention to it; but few if any tribes have ignored it or relegated it to an insignificant place.

The ideas about death and the customs associated with it are as various as are the tribes. They have been formed under the influence of the surroundings and local circumstances among which the people have lived, have been molded by religious beliefs and institutions, and have been affected by historical changes. A substantial sameness in reference to them prevails at this time among civilized nations, particularly in the higher and more cultivated classes; but, even in these nations, we have to go only a little way into the rural districts, among the peasantry, to find the most quaint and curious customs still in vogue, coming down from the times of heathenism and barbarism, before conventionality had become the potent social force that it is. Very interesting illustrations of these survivals of old-time notions may be found in the provinces of Hungary, whose polyglot nationalities of various origin and history have hardly yet begun to feel the influences that have nearly reduced the busy population of the cities to a European homogeneity. A few of the most striking customs of these peoples have been studied by Herr Hugo Klein and described by him in "Das Ausland," and from his article is derived what follows in that division of our subject.

A characteristic of the funeral ceremonies of the Magyars is the feast which is eaten by the relatives and friends of the deceased after the burial, and is frequently accompanied by religious songs. The custom is beautifully illustrated in Palota, where the hymns are sung as the guests separate. The singing is continued on the streets, and the soft, clear tones of the dirge can be heard in all parts of the town. In Agard, fruit-trees are planted around the graves, to mark them in the years to come after time and the elements have removed the wooden crosses that are set at their heads. In Bonghad, the dead were formerly escorted with torches to their eternal rest.

The funeral pomp formerly displayed by the Magyars in Transylvania reached a mark that defies description. The coffin was covered with gold-embroidered velvet fastened with silver nails bearing the arms of the deceased. The man's weapons and the woman's jewels and dresses, frequently to the value of many thousands, were deposited in the grave. If the deceased was a great land-holder, the bells were tolled twice a day from the time of death till the burial, and all the families within the circle of his acquaintance were invited to witness the ceremonies, so that sometimes the village could hardly contain all who came. Special officers were appointed to direct the proceedings, and these, with the magnificent catafalque and the two armored knights who rode by its side, followed by the favorite horse of the deceased, and an attendant carrying his arms plated with silver, or a banner inscribed with his epitaph, constituted an imposing head to the long procession of black- or purple-clad mourners and guests. The services in the church were set off in a corresponding style. Many persons spent the income of weeks for prayers to be said for the deceased, to drape churches in black, to dress a legion of servants in mourning, or to furnish the torches for the funeral; and sometimes large collections of eulogies and verses were published to commemorate the good deeds which the dead man had performed in life. Funerals are told of that cost from ten to twelve thousand gulden—an immense sum in those days. The extravagance of these observances finally reached such a height that an ordinance had to be promulgated in 1747, limiting the expenditure that could be allowed.

In the grave-yards of the Palovzes, in the counties of Borsod and Heves, may be seen here and there pyramidal monuments of stone, with niches in their sides for images of the saints. They are a survival from the ancient heathen altars of these people, the Kumanians of old, which were erected in honor of the sun-god; and to this day also may be seen on many of the houses of the Palovzes the symbol of the pyramid with Baal's eye, the use of which has come down from generation to generation, without the peasants knowing what it means. Children who die still-born, or without having received baptism, are buried as near as possible to the pyramidal monuments. It is a part of the folk-lore of the Palovzes that the little ones who are laid to rest near these Baal-pillars will at the end of seven years come out from their graves, when, if some good soul will come near them and utter the baptismal formula, they will immediately become little angels and go to heaven; but, if the baptism is not given, they will have to wait seven years longer for another opportunity to be released. Many other reminiscences of Baal-worship survive among these people. The mother who has lost a young child wraps her head, as a sign of mourning, in a fiery red cloth. The former prevalence of cremation is indicated in the custom of burning the clothes which the deceased wore last. The tear-jugs of the ancients may still be found in the houses, of exactly the old form and size, but destined to a quite different purpose. Another peculiar custom at the funeral feast is to lay a plate with salt and bread upon the table, for the use of the soul of the departed one, if it should appear in the circle of friends.

The Servians put lighted candles in the hands of their dead, and a saint's image on their breast, and set lights around the bier. They leave all the furniture in the house undisturbed, so that the released soul shall not lose its way. For several days food and drink are taken to the grave.

The Roumanians preserve many of the customs of the Romans, from whom they claim descent. Men who have lost their wives signify their mourning by going bareheaded for six months.

To the Ruthenians, death is a greatly dreaded visitor, and calls out most demonstrative expressions of grief. They now put the pipe and tobacco-box of the deceased in the grave, as in ancient times they used to deposit his armor there. All the furniture is removed from the place before the dead man is taken from the house, so that the escaping soul shall not be held back by its attachment to the familiar arrangement of the room—a custom which in itself, and in the thought that suggests it, contrasts curiously with the Servian fashion. When the coffin is being borne out, it is set down upon the door-step, so that the walls of the house may know that one of its inmates has left it.

The custom of providing the deceased with an obolus, or a piece of money to pay the ferryman over the river of death, prevails among the Roumanians, who derive it from the Romans, and among the Slovaks of North Hungary, who never had anything to do with the Romans. Among the Slovaks, the coffin of a young girl is red, while her dress is black, that being to them the color of innocence, and a sprig of rosemary is put in the hand of the corpse. A lighted taper is set at the head of the casket.

Among barbarous and savage races, the diversities in funeral customs are endless, and often mark strange and paradoxical notions of life and death. They may still be witnessed in the islands of the sea and in the "Dark Continent," where civilization and foreign influences have hardly made a scratch, in all their pristine originality and freshness. A large book would not suffice to contain the descriptions of them all. We give here only a few of the hundreds of specimens we might present, culled from the most recent accounts of travelers and missionaries:

Herr F. Grabowsky relates, in an account of that people, that the Maanjans of Southeastern Borneo set great store upon dying in their own house, and on having their funeral celebrated in their native village. When the signal of death is sounded in solemn, rhythmic beats on the *garangtong*, the village is supposed to become partially unclean, and particular observances are imposed on the people. The soul of the deceased is imagined to wander about the place uneasily till the funeral services are performed, and the night to be its day. Hence, every person who has to leave the place for any reason makes it a point to do so before sunset; and, if he has to go out later, he avoids speaking to anybody, and every one shuns him. According to the superstitions of this people, the souls return from the spirit-world to the earth after seven generations; and, if a pregnant woman craves, for instance, sour fruits, it is said that a soul from the other world has returned to dwell in her, in order to be born to life again. As soon as the dying man has breathed his last, the mourning-women begin their howling, the corpse is dressed and set in funeral array ; a fowl is slaughtered ; the coffin is prepared, and the body crowded sidewise into it. Half the clothes, money, rice, and usual necessities of life of the deceased, and the feet of the slaughtered hen, are placed in the coffin with the body, while the rest is consumed by the mourners. The grave is built up in the form of a stepped pyramid, the terraces of which are supported by planks, and over it is erected a canopy under which are deposited articles which the deceased has used. At seven and at forty-nine days after the burial, a second and a third fowl are slaughtered, and a part of them is carried ceremonially to the grave. The term of forty-nine days marks the period of mourning for an adult, while only seven days are given to a child ; and during this time the family must refrain from eating rice and satisfy themselves with a less desirable and much less palatable kind of grain. With the observance of this season all the duties toward the dead are fulfilled till the time of the *djamä*, or the feast in commemoration of the entrance of the soul into the spirit-world. This festival is celebrated every two or three years, and all the families in the village that have lost a member during the interval join in defraying the expense of it. An invitation to the *djamä* is one of those things that are not declined. The festival lasts through seven days, to each of which is assigned some feature in the preparation for the ceremonial of cremation. A crematory is built, to which the dead are brought, amid the howlings of the mourning-women. A brief formula is recited by the *wadian*, or priest, over each body, as it is brought up, and it is then lifted upon the hearth. After the burning the ashes are placed without any further ceremony in a vessel called an *agong*, and this is deposited in the *tambak*, or family sepulchre, a structure which is erected upon posts a short distance above the ground. Children under seven years of age are not cremated, but their bodies are placed at once in the *tambak*. They must be purified, however, before they can enter the heavenly city, and this is done by sacrificing a hog on the day following that of their death. Seven days after the *djamä*, the *siwah*, a feast of propitiation, is given, when priestly ceremonies are performed, with eating, drinking, and sports. The viands which are eaten at these feasts must not be allowed to touch the ground, and are therefore brought to the feasting-place on wooden stands from one to two feet high. The really important act of the *siwah* is the *manrus-ira*, or blood-bath, a ceremonial that might well excite horror. Four fowls, four goats, and four swine, are slaughtered on a latticed platform, and their blood is allowed to drip down upon the ground below. The multitude rush to the spot to bathe in the blood ; women with nursing infants, children of every age and both sexes, decrepit old men and vigorous young men, besmear their faces, their heads, their breasts, and in fact their whole bodies, with the warm streaming blood of the slaughtered animals, which are then cooked and eaten.

A missionary in Batavia states that the people of the Island of Sumba, in the residence of Timor, drape the corpses of their dead, and bind them in a sitting posture to a post which is planted in front of the house of the deceased. The body of a chief is allowed to remain there till it decays; but the bodies of other persons, after two or three days, are buried in a grave which is dug in the shape of a well, and is afterward covered with a heavy stone. The clothes of the deceased and his jewelry are buried with him. The friends of the dead man are expected, while the body is exposed, to visit it, bringing gifts of clothing and other articles of value. The graves are situated in the midst of the towns, and are carefully attended to by the inhabitants.

According to the descriptions of a Dutch missionary, the funeral feasts of the Island of Halmahera are quite elaborate affairs. The ceremonies begin, after the deceased has been put in his coffin, with a rope-dance between the young men and the maidens, in which either party tries to pull the rope away from the other, to the music of a monotonous antiphonal chant, and which is continued through several evenings, with complete freedom from interference by the old people. Then follow four or five days of feasting, to which the whole neighborhood is invited to contribute in provisions and services, marchers and dancers, the men and the women taking the prominent part in the ceremonies on alternate days. On the last day of the feast, as large a company as possible is collected, to give effect to the final ceremonies. The body is placed in the grave, and is adorned with ornaments, lights, and garlands, and supplied with dishes of betel and provisions. Another banquet is served, the rope-dance is repeated, and a new ceremony, called the *toku*, is performed. For this, the young men and the girls take places in opposite rows, each confronting pair joining hands. A child, festively dressed, is lifted up and made to walk upon the road formed by the pairs of hands, singing a refrain, to which the partners in the files chant a response. Each hand-joined couple in the rows withdraws as soon as the child has passed it, and takes a new place at the farther end, so as to prolong the walk to the extent that the occasion may seem to call for. As soon as this play is over, the rope-dance is transferred to the sea-beach, and the funeral ends with a ducking-match between the boys and the girls.

Dr. Miclucho Maclay describes the Orang-Sakai tribes of New Guinea as having a terrible fear of the dead. As soon as any one among them becomes critically sick, he is carried out into the forest and left there with a small supply of food. His hut is immediately destroyed, and no one will ever build again on the place where it stood. The remains of abandoned unfortunates are frequently met in the wilderness, as well as the ruins of huts which have been given up on account of the occurrence of death among their inmates.

Herr J. C. Dieterle has published an account of the curious royal funerals and "customs" of Tepi-Land, on the West Coast of Africa. According to him, when the king becomes dangerously ill, he is placed under the close care of a circle of chosen attendants. The fact of his illness must not be mentioned directly, but may, when that is necessary, be alluded to in some roundabout phrase, or as if it were the speaker himself that were sick. At the same, time the affairs of the court go on in their usual course, one of the chiefs representing the king and offering to the people, when inquired of, some plausible excuse for his majesty's absence. When death takes place, all who are cognizant of the event, if they have not succeeded in running away, are put under guard, and the secret is kept as long as possible. Generally, however, some manage to escape, and they will give the news to their friends in obscure hints, saying, perhaps, "Things are becoming dangerous," "The great tree has fallen," "Look out for the earthquake," but never plainly that the king is dead. Loud mourning is prohibited at this stage of the proceedings. The victims to be offered up are secured, and one is sacrificed, to lie at the feet of the corpse while it is prepared for burial. The body having been dressed and the head and breast sprinkled with gold-dust, if it can be afforded, his majesty's death is announced to the chiefs, still in some obscure phrase; as, "The king is unwell, and desires to see you," "The king has gone to bed and can not get up," "The only free is asleep"; and the chiefs, but no common man, under penalty of death, are admitted to view the body in private. The corpse is carried at crowing of the cock to the royal burial-place, where sheep are slain, and the favorite dishes of his majesty, of which no one is allowed to eat but the designated chief victims, are set before him. The chief victims have been selected beforehand, and are distinguished during life by a peculiar badge. They are sacrificed by breaking their necks, while the heads of the other victims are cut off by a band of executioners composed of relatives of his late majesty. The victims are usually persons who have committed some misdeed or have incurred the dislike of their fellow-slaves, and with them are offered up persons who have been sentenced to punishment and kept in reserve for the occasion. After these ceremonies are over, the wives of the king that have not been dispatched after him assemble around a ceremonial coffin and set up the stated mourning. The wives are expected to observe the conventionalities of mourning till they are given to the new king to be his wives, and this can not happen till after the celebration of the "customs," which is frequently delayed for a long time on account of the expense. The successor to the throne is chosen after consultation between the chiefs and the women of the royal family, in secret. Having been publicly proclaimed, the new king is instructed as to his own rights and duties and those of the tribe, is sworn to observe all that is prescribed, and then receives the homage of the chiefs, after which the royal feast is given and the royal gifts are bestowed. The enthronement takes place on the occasion of the periodical festival of the *adäe*, when, in the midst of great feasts to the chiefs and their retinues, the throne is brought out and two of the nobles set the new king upon it three times, with the prayer: "Spirits of all the deceased kings, bless this our new king! Give him riches, health, and great honor before all people and before all his fellow-kings!" Sheep are sacrificed, court is held, and the people are entertained with dancing and a great noise. The "customs" for the deceased king do not take place till after the ceremonies of enthronement; and, as they involve great expense, they may be postponed for months or for years. They last for eight days, during which time every one in the capital must keep his head shaved and wear a prescribed dress. Another sacrifice of men is made, to which the chiefs must contribute in victims or money; and it is made with imposing publicity, amid the firing of guns and drumming and dancing. During all the ceremonials, from the death of the old king down, the executioners and guests from abroad and the members of the band that performed the burial of the king enjoy special privileges of taking what they like; and solitary persons find it prudent to keep out of their way. During the "customs" a figure intended to represent the deceased king is set up and honored with the characteristic noisy ceremonial of the people. Finally, it is carried away and deposited in a shrine; and this marks the end of the whole matter.

Whenever any one among the Hereros of Damara-Land, South Africa, becomes sick unto death, says the missionary C. G. Büttner, it is the custom for all the relatives of the sick man and the people of the vicinity to gather around his bedside, in such throngs as to fill the house, and witness the death. In health the Herero is satisfied to lie upon the bare ground, but, as soon as he becomes seriously ill, it is the imperative duty of some one of his near relatives to sit down by him, and hold his head with tender care. The people are not willing to recognize that any one can die from a purely natural cause, but always try to attribute the death to some external injury; and, if nothing of the kind can be detected, they will lay it to some accident, even of the most trifling character, that may have occurred years before; and if any one is known who has ever attacked the deceased, or struck him, he is liable to be fixed upon as the responsible agent. The body is buried at some spot near the place of death, sometimes in the spot itself, but, if the deceased was a very bad man, it is carried off as far and to as desolate a spot as possible, so that the ghost shall not come back and work mischief. Everything that belongs to the grave is tabooed, and must not be taken away under any circumstances; and so strictly is this rule observed, that, although fire-wood is extremely scarce, the palings that have been driven around the spot, and fallen down, or the hedge-bushes that have died may rot and disappear, no one will touch them. The burial is followed by a season of mourning, the ceremonial of which is performed by a band of hired mourners. The finest of cattle of the wealthy land-owner are slain, not by the usual method of stabbing, but by cutting off their heads, that their horns may be used to adorn the grave. The flesh of the cattle is given to be eaten to those who will in return join the band of mourners for a specified term. If the cattle are not slain all at once, but by installments, the means are thereby secured of prolonging the period of mourning for as long a time as the meat will hold out. It is common, after the head of a house has died, to remove the *werst,* or family residence. It is possible that this is done to get away from the malaria which the sickness and death of members of the family give notice has settled down upon the place ; for malarious influences have been found to linger over into the year following one of extreme sickness. The children visit the graves of their parents only rarely, and then with much ceremony, to consult the oracle of their ancestors ; and sometimes the oracle proclaims that the deceased desires again to enjoy the lowing of his cattle, when the son repairs to the grave with the herds. The Hereros are almost universally in as great terror of ghosts as any child among Europeans ; and the household legends, which are transmitted from generation to generation, consist for the most part of stories of returned spirits. No one will venture out alone in the thick darkness ; and, if one has to go at night for the missionary-doctor, he will not stir out without a companion. Nothing in the world, says Herr Büttner, would move them to go into an anatomical museum, or to witness a dissection. Little as it troubles them to slay a beast, they will not lay hands on a human corpse without extreme compulsion. "The pictures in my anatomical atlas were an object of horror to them. When, during my last few months in Damara-Land, I was buying from the natives whatever I could get for specimens, I succeeded in overcoming their dread sufficiently to induce them to sell me a considerable number of magical charms ; but not one of them would venture to bring me a skull, whatever price I offered them. A long box in which I had packed a lot of lances and bows, and which looked somewhat like a rough coffin, was a terror to all the people of my house, for how did they know that I was not going to fill it with the men's bones I was trying to buy ? It was amusing to see how the men who afterward had to handle this box, lift it upon the wagon, etc., hurried with the greatest fear, so as to get it out of their hands as quickly as possible."

SKETCH OF LORD RAYLEIGH.

WE publish an excellent portrait, this month, of the subject of the present sketch, Professor Lord Rayleigh, President of the British Association for the Advancement of Science, which held its annual meeting this year at Montreal.

John William Strutt, Baron Rayleigh, of Ferling Place, Essex, was born November 12, 1842. He had a delicate constitution, which it was feared would render the exposures of the public school dangerous, and he was accordingly placed under the charge of the Rev. J. T. Warner, of Torquay. He early developed a fondness for experimental research, and his chief amusement while a youth was photography. In October, 1861, he entered Trinity College, Cambridge, and was there classed among the "reading-men" by his fellow-students. He took several prizes and an exhibition in the course of his studies, and graduated with distinguished honors, being both senior wrangler and Smith's prizeman. Following the usual custom, when a student of a college has distinguished himself in the final examinations, Trinity College elected him a Fellow.

In 1871 Mr. Strutt married the second daughter of the late James Balfour, of Whittingham, Scotland, thus losing his fellowship, to which only celibates are eligible. On the 14th of June, 1872, he succeeded to the title, and in the same year was elected a Fellow of the Royal Society, to whose transactions he has contributed many important papers. The medal of this society was conferred upon him in 1882 as a recognition of the importance of his scientific work. In 1879, upon the death of Professor Clerk-Maxwell, who had filled the chair since its establishment in 1871, Lord Rayleigh was appointed Professor of Experimental Physics in Cambridge. Since then, he has devoted much of his time to the organization of the magnificent Cavendish Laboratory, the gift of the Duke of Devonshire, chancellor of the university.

Lord Rayleigh was elected President of the British Association last year at its Southport meeting, and succeeds Professor Arthur Cayley, who is so well known for his devotion to pure mathematics, also in the University of Cambridge. The selection of a lord for the presidency of this body is not without abundant precedent, several distinguished noblemen, as Prince Albert, the Dukes of Argyll and Northumberland, Lord Wrottesley, and others, having occupied the position, which has given rise to the insinuation that this body has a weakness for great titles. But, in the first place, the British Association is not a republican club, but a body of men wise and practical in their generation, and who know how to adapt means to ends for the successful accomplishment of the objects they have in view. And, in the next place, the nobleman who presided at Montreal is not merely a lord, but a man of very distinguished ability and eminently entitled to the honor from both the character and extent of his original scientific work. His writings, however, are only or chiefly known to scientific men. Numerous papers from his pen are scattered through the pages of the proceedings of several learned societies of England, though some of them have been collected into a volume and published separately. He has produced but one extensive work, namely, "The Theory of Sound," a mathematical treatise in two volumes. It was begun on the Nile in 1872, and published in 1877–'78. The article on "Optics," in the last volume of the "Encyclopædia Britannica," was also written by him. His determinations of the ohm, which were presented to the Paris Conference of Electricians in 1883–'84, have been accepted as the basis of the unit of electrical resistance. His recent experiments in methods of practically measuring the strength of the electric current point to the method, by the deposition of silver, as one capable of furnishing a high degree of accuracy.

To these scanty particulars of Lord Rayleigh's life and career, for which we are mainly indebted to a brief sketch in the Montreal "Star," we may add the estimate of his work given by Sir William Thomson in introducing him to the large audience at the first assemblage of the Association in Montreal, August 27th, when he assumed the presidential chair. Referring first to the work of his predecessor, Sir William Thomson remarked: "Professor Cayley has devoted his life to the advancement of pure mathematics. It is indeed peculiarly appropriate that he should be followed in the honorable post of president by one who has done so much to apply mathematical power in the various branches of physical science as Lord Rayleigh has done. In the field of the discovery and demonstration of natural phenomena Lord Rayleigh has, above all others, enriched physical science by the application of mathematical analysis; and when I speak of mathematics you must not suppose mathematics to be harsh and crabbed. (Laughter.) The Association learned last year at Southport what a glorious realm of beauty there was in pure mathematics. I will not, however, be hard on those who insist that it is harsh and crabbed. In reading some of the pages of the greatest investigators of mathematics one is apt occasionally to become wearied, and I must confess that some of the pages of Lord Rayleigh's work have taxed me most severely, but the strain was well repaid. When we pass from the instrument which is harsh and crabbed to those who do not give themselves the trouble to learn it thoroughly, to the application of the instrument, see what a splendid world of light, beauty, and music is opened to us through such investigations as those of Lord Rayleigh! His book on sound is the greatest piece of mathematical investigation we know of applied to a branch of physical science. The branches of music are mere developments of mathematical formulas, and of every note and wave in music the equation lies in the pages of Lord Rayleigh's book. (Laughter and applause.) There are some who have no ear for music, but all who are blessed with eyes can admire the beauties of Nature, and among those one which is seen in Canada frequently, in England often, in Scotland rarely, is the blue sky. (Laughter.) Lord Rayleigh's brilliant piece of mathematical work on the dynamics of blue sky is a monument of the application of mathematics to a subject of supreme difficulty, and on the subject of refraction of light he has pointed out the way toward finding all that has to be known, though he has ended his great work by admitting that the explanation of the fundamentals of the reflection and refraction of light is still wanting, and is a subject for the efforts of the British Association for the Advancement of Science. But there is still another subject, electricity and the electric light, and here again Lord Rayleigh's work is fundamental, and one may hope from the suggestions it contains that electricity may yet be put upon the level of ordinary mechanics, and that the electrician may be able to weigh out electric quantities as easily and readily as a merchant could a quantity of tea or sugar."

Lord Rayleigh is a man of modest deportment but a very strong man. It was feared that his inaugural address would be an abstruse performance little calculated to interest a general audience, but the apprehension turned out to be groundless. The discourse was full of compressed thought, but closely interested his hearers, and was a model as a survey of the recent advancement in physical science. It was delivered in a clear and effective style, well measured, but without the least hesitancy of speech. In this respect the man of the laboratory of mathematics and of research contrasted strongly with many of those literary Englishmen whom we might suppose would cultivate somewhat the art of delivery; but in all respects Lord Rayleigh's manner of speaking was in sharp antithesis to the style, for example, of Mr. Matthew Arnold.

EDITOR'S TABLE.

THE SCIENTISTS AT MONTREAL.

THE Montreal Congress of British Scientists, which was at first thought to be a very dubious experiment, turned out a success. Some nine or ten hundred members of the British Association crossed the sea, and, with the accessions from Canada, and a strong representation from the United States, the meeting became very large, and a great deal of excellent work was done. The address of the president-elect, and the inaugural addresses of the presidents of the several sections—of Sir William Thomson in Physics, of Sir Henry Roscoe in Chemistry, of Professor Blanford in Geology, of Professor Moseley in Biology, of Sir J. H. Lefroy in Geography, of Sir Richard Temple in Economics and Statistics, of Sir F. J. Bramwell in Mechanics, and of Mr. E. B. Tylor in Anthropology — were all productions of high, if not exceptional, ability. Many important papers were contributed to the several sections, while the attendance upon their meetings was large and the interest well sustained. Of course, the Canadians were delighted, as they had a right to be. They were proud of the compliment paid to the Dominion by the coming of so dignified and distinguished a body of scientific men to hold one of its customary meetings in Montreal; and were especially pleased that the Queen should have graciously conferred the honor of knighthood upon their leading man of science, Principal Dawson. Of course, there were inconveniences accompanying so large a gathering in a city not provided with accommodations on the largest scale. The reception at the Redpath Museum, given by McGill University, was a painful crush, productive of far more discomfort than pleasure, but the accommodations for the practical work of the sections in the university were more satisfactory. Every hospitality was extended to the strangers by the citizens of Montreal, and the press of that city manifested a creditable enterprise in reporting the proceedings and publishing important papers. The Governor-General, in his address of welcome, as was natural for a politician, used the occasion to magnify Canada as an important constituent of the British Empire, and appreciated the immense advertising that would come from this visit of the home scientists. Altogether, it was a memorable occasion; everybody was gratified, and its influence will, beyond doubt, be most favorable to the cause of science.

THE ELEVATION OF PHRASES ABOVE THINGS.

THE inaugural address of Professor Lord Rayleigh at Montreal, which we publish in full, is an able discussion. As a review of the recent progress of physics it is very instructive, full of practical suggestions, and fair to the workers of all countries. But there is one feature of it which we think deserves especial commendation, and that is the independent and common-sense way in which it refers to the issue between the dead languages and scientific education. He might easily have evaded the subject, and, being a Cambridge man, it was rather to be expected that he would lean toward the side of tradition. But he did not shrink from his duty to recognize the importance of the question on this conspicuous occasion, and to represent decisively its scientific side. The position which he took was moderate but firm, and he indorses with emphasis the main propositions advocated by the friends of scientific education. He says: "To them it appears strange, and almost monstrous, that the dead languages should hold the place they do in general education; and it can hardly be denied that their supremacy is the result of routine rather than of argument." After declaring his doubts whether an exclusively scientific training would be satisfactory, he adds: "But it is useless to discuss the question upon the supposition that the majority of boys attain, either to a knowledge of the languages (Latin and Greek) or to an appreciation of the writings of the ancient authors. The contrary is notoriously the truth." This is a broad indorsement of the assertion that the study of the dead languages is generally, as a matter of fact, a failure. He further observes: "I believe that French and German, if properly taught, which I admit they rarely are at present, would go far to replace Latin and Greek from a disciplinary point of view, while the actual value of the acquisition would, in the majority of cases, be incomparably greater. In half the time usually devoted, without success, to the classical languages, most boys could acquire a really serviceable knowledge of French and German. History and the serious study of the English literature, now shamefully neglected, would also find a place in such a scheme."

We put these unsolicited and responsible declarations of an English university man, who has had both a classical and a scientific training, against the one-sided expressions drawn by the classical party from Lord Coleridge and Matthew Arnold while in this country.

But it is not this aspect of the matter — a mere question of conflicting authorities—that chiefly concerns us here. Lord Rayleigh had previously made an incidental observation which strikes deeper into this subject than anything he said in his formal reference to it. He was speaking of the character of his celebrated instructor, the late Professor Clerk-Maxwell, of whom he said, "As a teacher and examiner he was well acquainted with the almost universal tendency of uninstructed minds to elevate phrases above things." This goes to the root of the antagonism between literary and scientific education, considered as means of mental cultivation.

Literary education is carried on in the world of *words;* scientific education, truly such, goes on in the world of *things*, in which words, though indispensable, are subordinate, and not the substantive objects with which the mind is engaged. Literature, as a method, stops with the words, makes the things for which they stand of little account, and is occupied with the arts of expression. In science, things are uppermost, they are what the mind really has to deal with, and their verbal representatives are merely matters of convenience in dealing with them. But the literary mind exalts the symbols to the higher place, and makes education consist in loading the mind with languages, with but little conception of those higher ends to which all language should be made tributary. Of course, it is easier and more pleasant to become interested in words and pay little attention to things, and, where the object is only light intellectual gratification, literature answers the end.

But we have here to do with the subject of education, with the true and best mode of developing the powers of the mind, and for this purpose the difference between words and things is wide and fundamental. Both are important, but the question is, which is to be held supreme? Science as a new force in education relegates words to the subordinate place, and it clinches the case by affirming that knowledge of things is the true test of intelligence, and that the mere knowledge of words is but highly respectable ignorance. Unless there has been a grapple with some subject in its actual facts, elements, and relations, and some considerable degree of mental discipline in the search for truth, the observation of objects, and the study of principles, there has been no genuine education. For it is with facts at last that we have concern in experience, and the education of him who has not learned to study them is futile. The dictum of Clerk-Maxwell and Lord Rayleigh that there is an "almost universal tendency of uninstructed minds to elevate phrases above things" has all the effect of a new definition of ignorance. This idea has been long foreshadowed in a vague recognition of the ignorance of mere book-worms, and in all the exigencies of a practical life the worthlessness of simple book-knowledge is proverbial. The antithesis of ignorance is not learning but knowledge. Thinkers undoubtedly get help from books, when they know how to use and subordinate them so as not to become their victims. One of the profoundest English thinkers, Hobbes, who has impressed himself powerfully upon the thought of the last two centuries, read but few books, and Aubrey remarks that "he was wont to say that if he had read as much as other men he should have continued still as ignorant as other men." Mere reading is not mental discipline, but rather mental dissipation, and one of the worst features of our popular education is the superstitious supremacy it gives to naked book acquisitions. The radical work of scientific education must be done here: "The almost universal tendency of uninstructed minds to elevate phrases above things" must give place to the more rational and enlightened tendency to elevate things above phrases. It was inevitable that the verbal should be in the ascendant in ancient times, and in the mediæval ages, when but little was accurately and profoundly known of the relations of things; but science has given us a new dispensation of knowledge, and this has created a new education in which knowledge is no longer a matter of phrases, but a familiarization of the mind with the verities of nature and of truth. In this new education, language, conceded to be of great importance, is not an end in itself, but is to be made tributary to the higher end of understanding the nature, order, and constitution of things.

LITERARY NOTICES.

The New Chemistry. By Josiah Parsons Cooke, LL. D. Revised edition, remodeled and enlarged. New York: D. Appleton & Co. Pp. 400. Price, $2.

All who are interested in the progress of chemistry will be glad to learn that Professor Cooke has thoroughly revised his interesting volume in the "International Scientific Series," entitled "The New Chemistry." It took a position in all the languages in which it appeared, both as a model of admirable exposition and a standard work on the present condition of chemical theory. But, excellent as it was when first published, the author has not been content to let it go unrevised when there has been further important progress, both of the science and of his own views of the subject. He has accordingly revised and amplified it so that it may now be accepted as an authoritative statement of the present condition of chemical philosophy. We reproduce the author's preface to the new edition, that our readers may know exactly the import of the changes that have been made in the book:

The progress in chemistry during the ten years which have elapsed since this work was first published and stereotyped has been accompanied by no such revolution in its philosophy as the previous transition from the dualistic system of Berzelius to the unitary system of structural organic chemistry had involved. Nevertheless, there has been a constant advance, during which we have gained clearer conceptions and more comprehensive views of the fundamental principles of the science; and many of the accidental features which marked the transition period have disappeared. Meanwhile the distinction between elementary substances and materials consisting of isolated elementary atoms has become clear, and, in making these last, alone, the elements of chemistry, we have pushed our science, if not to its extreme limits, still one step further back: and in taking this step we have left behind many of the anomalies which previously encumbered our philosophy. Except in a very limited sense, the so-called elementary substances are now seen to be as truly compounded as any other substances, and it is manifest that their qualities must depend on molecular structure, or on the resulting dynamical relations, as well as on the fundamental attributes of the ultimate atoms. There is, therefore, no longer any reason for limiting the statement of the great fundamental law of definite proportions to the relations of elementary substance, and clearness of exposition is gained by giving to this statement the widest possible scope.

But unquestionably the most important advance in chemistry during the last decade has resulted from the study of the thermal changes accompanying chemical processes, which has proved that the law of the conservation of energy is a directing principle in chemistry as important as it is in physics. This study has developed an entirely new branch of our science called thermo-chemistry; and we now confidently look forward to a time in the near future when we shall be able to predict the order of phenomena in chemistry as fully as we now can in astronomy.

So important and fundamental have been the changes required by the recent progress that, in preparing this book for a new edition, the author has found it necessary to add a great deal of new material and in many places to rewrite the old, but he has endeavored to make the new edition, like the first, a popular exposition of the actual state of the science.

Health in the Household; or, Hygienic Cookery. By Susannah W. Dodds, M.D. New York: Fowler & Wells. Pp. 602. Price, $2.

By hygienic cookery the author means the preparation of predominantly vegetable dishes without stimulating condiments or the assistance of ingredients hard to digest. On this subject she is in her own preferences radical, for not only would she discard heating meats and spices and grease of all kinds, but she intimates that she would do away with milk, and, going behind even the uncorrupted instincts of animals in a state of nature, would abolish salt. Exalting grains, fruits, and vegetables, as the predominantly suitable staples of human food, she has something to say of the manner in which these things should be combined in a single meal—what of them should be eaten together—that deserves attention. Radicalism and the statement of principles constitute, however, but a part of the book. In the practical part the author is more catholic, and gives recipes for dishes both in "the hygienic dietary"—that is, a dietary strictly according to her principles—and in an enlarged dietary of "compromise dishes," into which meat dishes and the least deadly errors of modern seasoning are admitted. Hygienic people do not appear confined to a spare or monotonous diet. Mrs. Dodds's list is full and various, and some of the dishes are as good any the gourmands have. Including the compromise dishes, the dyspeptic who is strong enough to bear them can, after all, live like an epicure.

La Fabula de los Caribes. (The Fable of the Caribs.) By Juan Ignacio de Armas. Havana: Francisco S. Ibañez. Pp. 31.

This monograph is numbered I of a series of Americanist studies, and is a paper which was read before the Anthropological Society of Havana, at a date not given. It traces the fable of the Caribs—who were reported to be neighbors of the Amazons, to be cannibals, and to flatten their heads—from its origin with the ancients and its primitive location on the Black Sea, through the mutations it underwent with the authors of the middle ages, to its final location by the Spanish chroniclers in the newly discovered regions of tropical America. Having examined the grounds on which the characteristics first ascribed to the Chalybs of the Euxine were assigned to the Caribs of America, he finds that they were false, and that our Caribs were a people of mild and peaceful habits. "The fable of the Caribs," he says, "was in the beginning a geographical error; then a hallucination; and finally a calumny."

Reflex Nervous Influence, and its Importance as a Factor in the Causation and Cure of Disease. By D. T. Smith, M. D. New Orleans.

Reflex influence is that property of the nervous system by means of which, when one organ is affected, some other one responds to its call and acts instantaneously with it for the common good. It is an important factor in many relations of the individual to its environment; and familiar instances of its operation may be found in the daily actions of men and beasts. Dr. Smith conceives its function to be much more general than has been supposed, and would extend it to cases of disease. Thus colds are cases of the response of some correlated internal nerves, now of one part, now of another, to impairment of vitality in the cutaneous nerves. Poultices act favorably by stimulating the vitality and nutrition of nerves of skin covered by them, the exaltation of which is reflected to the deeper parts, and to the abscess whose maturity it is desired to hasten. The ordinary remedies for the relief of inflammation, and medicines which can not directly reach the part it is desired to affect, operate by reflex action. Restoration of the tone of the stomach may be promoted by the taste, sight, or smell, of pleasant food, and expectoration is stimulated by the swallowing of remedies that can not be expected to reach the mucous membrane of the respiratory passages, simply by the operation of the principle under consideration.

Report on the Cotton Production of the State of Florida: With an Account of the General Agricultural Features of the State. By Eugene Allen Smith, Ph. D. Tuscaloosa, Ala. Pp. 77.

As bearing upon the subject of the report, Professor Smith gives in this paper, besides matters immediately relating to cotton, an outline of the physical geography and geology of the State, embodying a review of what has already been hitherto done in this field, together with a synopsis of the results obtained by himself during the summer of 1880. The geological structure of Florida has been very much misunderstood, and the author's observations, presenting the matter in a correct view, are a positive addition to knowledge.

Sixteenth and Seventeenth Annual Reports of the Peabody Museum of American Archæology and Ethnology. F. W. Putnam, Curator. Cambridge, Mass. Pp. 132.

The out-door work of the Curator of the Museum in 1882 was directed chiefly to the exploration and examination of the prehistoric works of various kinds on the Little Miami River, principally in Hamilton County, Ohio. The curator also examined some shell-heaps on the coast of Maine, and explored a large mound and a cemetery in Williamson County, Tennessee. Valuable contributions to the work of the museum were made by Dr. C. C. Abbott, in the gravels of Trenton, New Jersey, and by Miss Alice C. Fletcher, the fruits of her residence among the Indian tribes. In 1883 the explorations on the Little Miami were continued; excursions were made by the curator to the works in Wisconsin and in the Scioto Valley, Ohio; and reports and collections were received of investigations in North Carolina, New Jersey, Delaware, the Zuñis of New Mexico, Massachusetts, Little Falls (Minnesota), and Nicaragua. Miss Fletcher was enabled to trace a relation between some peculiar features of the Madisonville works in Ohio and past customs of the Omaha Indians. The museum was enriched by the gift, from Thomas G. and Captain Nathan Appleton, of a collection from the Chiriqui graves, Panama. The report gives several papers in full on Indian customs, etc., by Miss Fletcher and other writers, and lists of additions to the collections, which now embrace 33,150 entries.

Archæological Institute of America. Fifth Annual Report of the Executive Committee, and Third Report of the American School of Classical Studies at Athens. Cambridge, Mass.: John Wilson & Sons. Pp. 118.

The report records the continuation and completion, for the present, of the excavations at Assos, in Asia Minor, the relics of which are "now one of the most interesting revelations of classical antiquity," and the very interesting explorations of Mr. Baudelier in the antiquities of New Mexico. A few remarks are offered respecting the value of the excavations at Assos, and of Greek civilization generally, to modern life. Fifteen colleges have co-operated in the maintenance of the classical school at Athens, which was under the direction, for the year, of Professor Lewis R. Packard, and is to be led for the coming year by Professor J. C. Van Benschoten, of Wesleyan University.

The Theories of Darwin and their Relation to Philosophy, Religion, and Morality. By Rudolf Schmid. Translated from the German by G. A. Zimmerman, Ph. D., with an Introduction by the Duke of Argyll. Chicago: Jansen, McClurg & Co. Pp. 410. Price, $2.

The author of this book is President of the Theological Seminary at Schönthal, Würtemberg. His purpose is to examine the various German versions and extensions of Darwinianism, and, comparing them with the views of the English Darwinian school, to ascertain the effect of each and all upon religious opinions and principles. Among the diversified phases of the subject, as it is presented by the different authors, he finds himself "led into the presence of a series of most interesting problems, but not a single solution finished," and has, therefore, been obliged to widen his investigation, "and to discuss even all imaginable possibilities. The beneficent result of this comparison was," he continues, "that religion and morality not only remain at peace with all imaginable possibilities of scientific theories, but can also, in the realm of the philosophy of the doctrines of nature, be passive spectators of all investigations and attempts, even of all possible excursions into the realm of fancy, without being obliged to interfere." Only in metaphysics is an antagonist found, in the attempt to eliminate from nature the idea of design, whose victory would be dangerous; but this thought is dismissed as in opposition "not only to the whole world of facts, but also to all logical reasoning."

Manual of the Mosses of North America. By Leo Lesquereux and Thomas P. James. Boston: S. E. Cassino & Co. Pp. 445, with Six Plates.

Mr. Lesquereux is known as one of the oldest and most experienced American botanists, and as one of the highest authorities in those fields of the science in which he has been engaged during his working life. In 1848 William S. Sullivant published, in the first edition of Gray's "Manual of Botany," descriptions of 205 species of mosses and 66 of hepaticæ; and in the second edition of the same work, in 1856, descriptions, with illustrative plates, of 410 mosses and 107 hepaticæ. He then began, in connection with Professor Lesquereux, a separate volume on mosses, but the work was interrupted by disability of Professor Lesquereux and the death of Mr. Sullivant. It has since been resumed and pushed to completion, with the aid of the material already collected, by Professor Lesquereux, assisted by Mr. James in microscopic analysis; M. T. Renauld, a French bryologist, in special examinations; and Mr. Sereno Watson, in revising and editing. The result is the present noble volume, which includes descriptions of all the species of mosses (about nine hundred) that are known to occur on our continent, within the limits of the United States and northward.

On a Carboniferous Ammonite from Texas. By Professor Angelo Heilprin, of Philadelphia. Pp. 3.

This is a monograph on a new ammonite, named by the author *Ammonites Parkeri*, obtained from the carboniferous strata of Wise County, Texas, which is noteworthy as being the first ammonite that has been detected in any American formation below the Mesozoic series. Carboniferous ammonites have also, however, been found in India.

Fire-Proof Buildings with Wooden Beams and Girders. New York: W. H. Dolman, 229 Broadway. Pp. 14.

An exposition of the character and merits of Dolman's fire-dampers, a device for fire-proofing wooden beams and floors by packing the beams or deafening the space under the floors with ashes, which is claimed to be cheap, effective, and easy to adapt.

Wages and Trade in Manufacturing Industries in America and Europe. By J. Schoenhof. New York: G. P. Putnam's Sons. Pp. 25. Price, 15 cents.

This essay is published, with an introduction by R. R. Bowker, under the auspices of the New York Free Trade Club. It is intended to answer the communications in the "New York Tribune" of Mr. Robert P. Porter on the same subject, who, having been dispatched to Europe as a special correspondent in the interest of protection, "did what he was sent to do," and "presented a picture of the distress of England under free trade and of the prosperity of France and Germany under a protective tariff that was much of a surprise to those who know most of those countries." An opposite view is here given.

A Hand-Book of Hygiene and Sanitary Science. By George Wilson. Fifth edition, enlarged and carefully revised. Philadelphia: P. Blakiston, Son & Co. Pp. 512. Price, $2.75.

This is a very full and at the same time closely condensed manual of facts and principles in the whole field indicated by the title, arranged under the general heads (with many divisions and subdivisions) of "Public

Health and Preventable Disease"; "Food"; "Air, its Impurities and their Effects on Public Health"; "Ventilation and Warming"; "Examination of Air and Ventilation"; "Water"; "Water Analysis"; "Impure Water, and its Effects on Public Health"; "Dwellings"; "Hospitals"; "Removal of Sewage"; "Purification and Utilization of Sewage"; "The Effects of Improved Drainage and Sewage on Public Health"; "Preventive Measures" (disinfection); "Vital Statistics"; and "The Duties of (English) Medical Officers of Health."

Reforms: Their Difficulties and Possibilities. By the author of "Conflict in Nature and Life." New York: D. Appleton & Co. Pp. 229. Price, $1.

Many who read that remarkable book, by an anonymous author, entitled "Conflict in Nature and Life: a Study of Antagonism in the Constitution of Things," which was published last year, were so deeply interested in the views presented, and so struck with their possible bearings upon various practical questions, as to indulge the hope that the author would resume his novel discussion, and work out some of the more obvious implications of his doctrine. This he has now done in the book before us, which, while in a certain sense a sequel or supplement to the former work, is still an independent treatise that must stand substantially upon its own merits. The work on "Conflict," as we pointed out at the time of its publication, was devoted to an explication of the dynamic view of Nature, which sees in it the action of forces ever resisted by other forces, so that the conception of conflict becomes the key to its universal operations. The radical ideas of that volume are thus restated in the author's introduction to the present work. He says: "A simple and primary form of antagonism is that of attraction and repulsion, which play so conspicuous a part in the phenomena of physics and chemistry. In biology, antagonism appears in manifold forms, in some instances somewhat obscure, but nevertheless everywhere present. Birth and death, growth and decay, waste and repair, development and degradation, are familiar examples. It appears in the never-ending struggle of individuals with individuals, of species with species, and of persistence of type with divergence of type. It is even exemplified by the rivalry of functions for vital energy from the organic sources in common, in consequence of which the over-activity of one may impoverish another, as when over-exertion of the brain exhausts the body, and early and over reproduction diminishes growth and development. Similar forms of antagonism pass over into the sphere of mind. At the bottom of the mental scale, and at the top, mental action is counteraction. There is no mental conception of properties except by contrast: one feeling antagonizes another; the mind is itself a system of balances, often fluctuating from one extreme to another; and the will is forever the theatre of emotional conflict. And all this antagonism is not incidental and transitory, as usually supposed, but fundamental and ineradicable."

But this policy of conflict is far enough from being confined to the inorganic, the organic, and the sub-human sphere of Nature. Man, with all his activities, is a part of the great unified natural order, and is to be as much studied in the light of this principle as any other divisions of phenomena. On this point the author observes: "Now, if this antagonism prevails in Nature, and is woven into the constitution of man, we should infer that the society which man forms would embody antagonistic elements in manifold forms of combination and interrelation. We should further infer that every attempt to act on human nature and on human society, for their improvement, should take an account of this ineradicable antagonism in the constitution of things in order properly to adapt the means to the end. A prevailing form in which this antagonism appears in life is in the essential coupling of the evil with the good, of a general evil with every general good. Now, in consequence of this union of evil with good, there is no such thing as perfection, and any attempt to bring about perfect results will fail. All that can be done is to effect the greatest possible good with the least possible evil. But reformers usually go to work in defiance of this principle; they have panaceas for every moral disease in the world, and are bound that every wrong shall be righted, and every evil exterminated, not seeing that, while they gain on one side, they are almost sure to lose on the other."

It was quite inevitable that the author should be led by this train of thought to an examination of the general subject of reforms. By this term has come to be understood that concerted and systematic effort which men put forth for the removal of evils, personal and social, and the attainment of a higher good through wiser action and better conduct. The reforms in which men and women engage are numberless, and are usually undertaken under the spur of a vivid sense of some evil to be removed, some suffering to be mitigated, or some great good to be achieved, rather than from any clear appreciation of how much it is possible to accomplish, or the danger of making matters worse by injudicious and intractable meddling. If ever amplitude of knowledge and cautious judgment are required for the guidance of human activity, it is certainly when experiments are to be made upon human beings in social relations for the purpose of attaining ideal results. But knowledge is generally not at a premium among reformers, and, instead of being men of dispassionate discernment and cool deliberation, they are too generally ardent and passionate, and even hot-headed and fanatical. It may be said that it is just these qualities that are needed to drive a reformatory crusade, and that nothing in this direction is ever accomplished by discreet and well-balanced men. But our experience with reforms and reformers—those who make it a business and a profession—is not such as to convince us that further knowledge on the philosophy of this important subject is superfluous.

For this reason we welcome the present book as a timely and valuable contribution to the question of the difficulties and the possibilities of reformatory effort. The author brings out a view of the subject that needed to be elaborated. It is a great subject, and his treatment of it is neither exhaustive nor faultless; but it is sufficiently full, cogent, and instructive to be of great public service. The writer modestly remarks: "It may be thought that more should have been said of the possibilities of reform. I could not say more on this point than has here been said without pretending to wisdom which I am perfectly conscious I do not possess. I believe there is need of some such presentation of the subject as an incentive mainly to a careful and judicious treatment of the great practical questions of the day."

The work is divided into three parts. Part I—consisting of five chapters, is devoted to the labor question—wages, saving and management, monopoly, schemes for industrial reform, etc. Part II—three chapters—takes up financial questions—money, protection, and monopoly. Part III—six chapters—is devoted to miscellaneous reforms—questions of every-day economics, some points in education, the woman and divorce questions, the temperance question, and issues of the near future. The work is neatly printed and brought out at a moderate price. It should have an extensive circulation, for the country is full of reformers.

Intellectual Arithmetic, upon the Inductive Method of Instruction. By Warren Colburn. Revised and enlarged edition. Boston: Houghton, Mifflin & Co. Pp. 216. Price, 35 cents.

To commend Colburn's Arithmetic would be like painting the rose. The system he introduced has held its place for sixty years, and educators are not yet ready to depart from its principles. The changes made in the present edition have been designed to make the "Colburn Method of Instruction" more apparent and attractive, or to bring the modes of expression and the objects referred to into conformity with the changed conditions of the life of to-day. A sketch of Colburn's life, his original preface, and George B. Emerson's introduction to the edition of 1863, are given in the Appendix.

Text-Book of Popular Astronomy. For the Use of Colleges, Academies, and High Schools. By William G. Peck, Ph. D., LL. D. New York: A. S. Barnes & Co. Pp. 330.

This book is intended to present, in a compact and popular form, all the facts and principles of astronomy that are needed in a general course of collegiate education. Mathematical formulas and demonstrations have been avoided as far as possible, and when introduced have been put in different type from the other matter. The order of arrangement of the matter is a little varied from the common order. The stars are treated of in a general way before any detailed consideration is given to the solar system. Instruments are described at those places in the text where their use is indicated in the general development of the course. Terms are defined where they may receive immediate illustration from the context. Subjects are arranged according to the author's idea of what is a natural and logical order.

Nippon Shoku butsu meii; or, Nomenclature of Japanese Plants in Latin, Japanese, and Chinese. By J. Matsumura. Supervised by Z. R. Yatabe. Tokio, Japan: Z. P. Maruya & Co. Pp. 300. Price, $2.

The author of this catalogue is Assistant Professor of Botany in the University of Tokio, and has done his work under the supervision of the Professor-in-chief of Botany in the same institution. But little more can be said in description of it than is given in the title. Twenty-four hundred and six species are catalogued in the alphabetical order of their recognized botanical or Latin names, with the authorities on which the names rest, and the equivalents for these names are given in Japanese, romanized Japanese, and Chinese. The list itself is a sufficient index to the Latin names; but three special alphabetical indexes are given for the Japanese, romanized Japanese, and Chinese names. The general execution and arrangement of the work are as nearly perfect as such things ever are; and in mechanical execution the book is equal to the best that has ever come from an American or European press.

Beginnings with the Microscope. By Walter P. Manton, M. D. Boston: Lee & Shepard; New York: Charles T. Dillingham. Pp. 73. Price, 50 cents.

The "Beginnings" is a working handbook containing simple instructions in the art and method of using the microscope and preparing objects for examination. It is easy to handle, easy to read, and easy to understand. The successful application of its directions must depend on the skill and industry of the student.

History of the Discovery of the Circulation of the Blood. By Henry C. Chapman, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 56. Price, $1.

This essay was the concluding lecture of a course on "The Circulation" delivered by the author at the Jefferson Medical College, during the term of 1883. Giving to Harvey the credit that is his due for grasping and formulating the law of the circulation, the author shows that the idea was entertained indefinitely in ancient times by Eristratus and Galen; that Servetus expressed some very intelligent ideas on the heart and its functions; that other writers had demonstrated particular features of the circulation, in an isolated way, before Harvey's time; and that it was not until after the appearance of Harvey's work that the discovery of the capillaries made intelligible the manner in which the blood passed from the arteries to the veins, and the demonstration of the lymphatics completed our knowledge on the subject.

Machinery of the Heavens. A System of Physical Astronomy. By A. P. Pichereau. Galesburg, Ill.: Plaindealer Printing Company. Pp. 142. Price, $1.50.

Mr. Pichereau is a practicing lawyer, who has kept up a living interest in astronomical questions and studies. While having the highest respect for astronomers, he is not fully satisfied with the sufficiency of their theories; he has thoughtout some hypotheses of his own, which he presents modestly, but with confidence, in this book. These theories relate to the causes of planetary axial rotations and orbital motions, the origin of worlds, the genesis of comets' tails, and the tides. If they can not be called scientific, it would be unjust to pronounce them contrary to science. They are plausible speculations pleasantly uttered by an amateur.

Physics in Pictures. With Explanatory Text prepared by Theodore Eckardt and translated by A. H. Keane. London: Edward Stanford.

In this work the principal natural phenomena and physical appliances in use are described and illustrated by thirty colored plates. Nearly every physical property of matter and ordinary manifestation of force is graphically represented, often with much ingenuity. In the first plate, for instance, the property of center of gravity is illustrated in a dozen ways, some of them amusing, in a two-page picture, which itself has no inconsiderable merit as a composition. Other plates explain the principles of the mechanical powers of simple and compound machines, the parallelogram of forces, density, the fire-engine, pumps, watch and clock works, mills, distilling apparatus, house-heating apparatus, steam-engines, ship-construction, electricity and its applications, the aurora borealis, and acoustics and optics, and the instruments in which they are applied, or are made subjects of investigation.

In the Heart of Africa. By Sir Samuel Baker. New York: Funk & Wagnalls. Pp. 284. Price, $1.

No one has done more to make the world acquainted with the regions of the Upper Nile and the Central African lakes than Sir Samuel Baker; and no one has conveyed the knowledge gained of them in a more entertaining and instructive manner than he. His two works, on "The Nile Tributaries of Abyssinia" and "The Albert Nyanza Great Basin of the Nile," are too large and expensive, and out of the reach of the mass of readers. The present volume has been condensed from them in such a manner as to omit that which is dry and only of detail, while the unity and thrilling charm of the narrative and the descriptive parts are retained.

The Globe Pronouncing Gazetteer of the World. Edinburgh: Oliver & Boyd; New York: G. P. Putnam's Sons. Pp. 463, with Thirty-two Maps. Price, $2.50.

The purpose of this "Gazetteer" is to furnish in a convenient form such a concise dictionary of geography as will, from its special features and cheapness, prove acceptable and useful to the general public. It gives descriptions of the different countries of the globe, and of their physical aspects and political divisions, and the location of their principal towns, etc., with the pronunciation, and, in many cases, the etymology of the geographical names. The first edition of the "Gazetteer" was published in 1879. The present edition has been thoroughly revised, and much new matter has been added.

Sorghum: Its Culture and Manufacture. Economically considered as a Source of Sugar, Sirup, and Fodder. By Peter Collier, Ph. D. Cincinnati: Robert Clarke & Co. Pp. 570. Price, $3.

It is the purpose of this work to present, in a systematic manner, all the most important facts relating to the economical production of sugar, sirup, and fodder from sorghum. The attempt is made to separate that which is demonstrable from the vast accumulation of statements, true and fanciful, that have been made since the plant was first introduced into the United States. The actual working results of numerous practical experiments in the production of sugar from this source have been given in detail, together with illustrations and descriptions of all necessary apparatus. The author's experience, as chemist of the United States Department of Agriculture, has given him excellent advantages for the study of different varieties of sorghum during all stages of development, the results of which he has endeavored to present, condensed and classified, in this volume. He has full faith in the possibility of making the production of sugar from sorghum profitable.

A Bachelor's Talks about Married Life and Things adjacent. By William Aikman, D. D. New York: Fowler & Wells. Pp. 272. Price, $1 50.

Dr. Aikman, infusing into his work the interest of a narrative and the easy grace of the informal essay, has given in this volume a series of sketches, more or less connected, on the different phases and events of married life, each of which, and the whole together, are intended to convey a moral or a salutary practical lesson.

Outline of Lecture Notes on General Chemistry. By John T. Stoddard, Ph. D., Professor of Chemistry in Smith College.—"The Non-Metals." Northampton, Mass.: Gazette Publishing Company. Pp. 84.

A brief statement of the general principles of the science occupies the opening pages of this little manual, and this is followed by notes as to the occurrence, preparation, properties, history, etc., of each of the non-metallic elements. It is adapted to accompany a course of laboratory work and lectures on this division of the elements.

Tokology: A Book for Every Woman. By Alice B. Stockham, M. D. Chicago: Sanitary Publishing Company. Pp. 277. Price, $2.

Tokology concerns the function of maternity. This book aims to teach women how they may build up their physical constitutions and those of their daughters, so as to fit their systems to endure safely what maternity demands of them, and to convey health and vigor to their offspring. Besides precepts concerning general physical development, particularly that of the womanly structure, it gives instructions for regimen and hygiene during the period of pregnancy, directions for the care of infants, hints for the alleviation of the pains of labor, observations on the disorders of pregnancy, and the alleviations of them, and on ventilation, baths, and gymnastics, with more than thirty pages on dietetics, embracing upward of a hundred recipes that are the outgrowth of experience.

The Man *versus* the State: Containing "The New Toryism;" "The Coming Slavery;" "The Sins of Legislators;" and "The Great Political Superstition." With a Preface and a Postscript. By Herbert Spencer. New York: D. Appleton & Co. Pp. 113. Price 30 cents.

Under this title the several articles by Mr. Herbert Spencer on social and political subjects, which have recently appeared in "The Popular Science Monthly," are now reprinted separately. As our readers know, they are vigorous protests against certain pronounced political tendencies of the times, which, as Mr. Spencer and many others believe, are full of danger to the cause of free government, and which at any rate deal with questions of great importance. The papers are issued in a cheap and attractive form, and the collection forms a very strong campaign document.

It may be thought singular that these discussions should be so classed, and many will be surprised that they should be published at this time, as they are not in the interest of any party, and will hardly be considered as belonging to the proper literature of a presidential canvass. But what can be more proper than to distribute through the community at the present time so able an examination of the principles which lie at the basis of free institutions? Every four years we in this country profess to remand to the people the whole subject of government policy, which is to be reconsidered, revised, embodied in new platforms, and represented by newly chosen men for the future guidance of the nation. This would, therefore, seem to be an especially suitable occasion to look closely into the tendencies of legislation, and to restate the principles which will best promote the true objects for which government is established. Pure partisanship is, of course, unfavorable to any such serious work, its objects being wholly incompatible with the grave consideration of primary political principles. So true is this, that the time which of all others would seem most appropriate for taking up fundamental questions of political policy is just the time when such questions are intentionally and systematically excluded from popular thought. So effectually are the most important subjects evaded and ruled out of the platforms that, as between the two great rival parties to-day, there is nothing of moment at issue. An election is to be won, and the canvass is to be made subservient to the personal ambition of the candidates, the getting possession of offices, and the distribution of patronage; and the introduction of fundamental issues of principle might disconcert the calculations of the politicians.

But unpropitious as the time might seem to issue a serious non-partisan document, appealing to intelligent and independent thinkers, there are strong reasons, nevertheless, for doing it, because the prevailing policy of the parties is far from having the unanimous approval of our most thoughtful citizens. There are many who protest vehemently against the vicious working of our partisan tactics. There are multitudes, and their numbers are increasing, who have become restive and are growing rebellious under these despotic party exactions, and that rule of intriguers which is fast making American politics the scandal and by-word of the world. Decent men are more and more disgusted with the empty pretenses, hypocrisy, and hollowness of our political life. They may acquiesce at last and vote the ticket of their party associations, but they denounce the system, and are ashamed of their own agency in supporting it. It is to such men, to whom the common literature of the canvass is mere chaff and rubbish, that such a document as this of Spencer's will make its successful appeal. Of the character of these papers it is unnecessary here to speak, but they have a living and permanent interest as masterly contributions to that phase of political inquiry which must absorb the attention of the coming generation. The problem of the function of government and the limits of its legitimate action must take precedence of all other political questions.

VAN NOSTRAND'S SCIENCE SERIES, NO. 76.

MODERN REPRODUCTIVE GRAPHIC PROCESSES. By JAMES S. PETTIT, First-Lieutenant, First United States Infantry. New York: D. Van Nostrand. Pp. 127. Price, 50 cents.

THIS little book was prepared for the use of the department of drawing of the United States Military Academy. It gives the outlines of about forty processes now in use for the reproduction of maps, drawings, and works of art, with details and formulas for such as are within the reach of amateurs. The processes are grouped as follows: Sensitive-paper processes, hektograph-printing, engraving, electrotypy, lithography, photography, and miscellaneous. Many of these processes which belong to the same group differ very little; their details are often trade secrets, and they are all, especially those in which chemicals are largely used, constantly undergoing improvements, and widening their range of application.

THE HOLLANDERS IN NOVA ZEMBLA (1596–1597). An Arctic Poem translated from the Dutch of Hendrik Tollers. By DANIEL VAN PELT. New York: G. P. Putnam's Sons. Pp. 120.

THIS poem, the work of the most esteemed Dutch poet of the century, relates the story of the famous voyages of Barents and his companions three hundred years ago, and their over-wintering in Nova Zembla. The translation has been prepared and given to the public at the instigation of Samuel Richard Van Campen, who, greatly admiring the original and its author, and being also interested in Arctic research, sought long for a writer who could adequately present its beauties in an English dress. He found such a writer in Mr. Van Pelt, who had already begun the work of his own accord. To the translation Mr. Van Campen prefixes an historical introduction, covering the Dutch voyages of Arctic exploration.

FIFTH AVENUE TO ALASKA. By EDWARD PIERREPONT. New York: G. P. Putnam's Sons. Pp. 329, with Maps by L. F. Beckwith. Price, $1.75.

THE author made the journey, the observations of which he has recorded in this volume, in company with his father, in the summer of 1883, by the Union Pacific Railroad, with the usual digressions to Salt Lake City, the Yosemite, and the Big Trees, *via* San Francisco, to Astoria, Portland, and the terminus of the Oregon and California Railroad; thence back to Portland, and through Puget Sound to Victoria; and thence to and through "the fiords, straits, bays, and inlets of Alaska, above two thousand miles." The return was by the Northern Pacific Railroad and the Yellowstone Park. What was seen is described in a simple, unaffected style, that seems designed to convey the exact impressions which the various adventures made upon the author.

PUBLICATIONS RECEIVED.

The Philosophy of History and the New Science of Sociology. By J. M. Long. Memphis, Tenn. Pp. 61.

The Unification of Longitudes and a Universal Time. By Benjamin A. Gould. Buenos Ayres. Pp. 12.

Annual Festival of German Pioneers, Cincinnati. Speech of Charles Reemelin. Pp. 23.

Public Health Laws of Illinois. Springfield, Ill.: State Board of Health, John H. Rauch, Secretary. Pp. 51.

Sewerage Systems, and the Epuration of Sewage. By Henry J. Barnes. Cambridge, Mass.: Riverside Press. Pp. 48.

Life and Public Services of Grover Cleveland. By Pendleton King. New York: G. P. Putnam's Sons. Pp. 224. 30 cents.

Catalogue of the State Agricultural and Mechanical College of Alabama, Auburn. Pp. 24.

United States Hay-Fever Association, 1884. Portland, Me.: Hoyt, Fogg & Donham. Pp. 36.

The Offices of Electricity in the Growth of Plants. By H. B. Philbrook, New York. Pp. 21.

Sawdust Gas. By George Walker. Pp. 15.

An Anarchist on Anarchy. By Elisée Reclus. Boston: Benjamin R. Tucker. Pp. 24.

Lightning-rod Humbugs. By J. K. Macomber. Pp. 8.

Chickering Classical and Scientific Institute, Cincinnati. Pp. 20.

Medical Education and State License. By Romaine J. Curtiss, M. D., of Joliet, Ill. Pp. 8.

Seven Hundred Album Verses. By J. S. Ogilvie. New York: J. S. Ogilvie & Co. Pp. 128. 15 cents.

Calcification and Decalcification of the Teeth By C. N. Pierce, D. D. S., Philadelphia. Pp. 7.

Barometric Waves of Very Short Period, pp. 11; Electric Potential and Gaseous Pressure, pp. 4. By H. M. Paul, Washington, D. C.

Proceedings of the Central Ohio Scientific Association. Urbana, Ohio. Pp. 17, with Plates.

Proceedings, etc., of the Kentucky State Sanitary Council, March, 1884, J. N. McCormack, Secretary. Bowling Green, Ky. Pp. 60.

Meteorites, pp. 7; The Argillite and Conglomerate of the Boston Basin, pp. 4; Relation of the Quincy Granite to the Primordial Argillite of Braintree, Mass., pp. 5; On the Trachyte of Marblehead Neck, Mass., pp. 7; Rocks and Ore Deposits in the Vicinity of Notre Dame Bay, Newfoundland, pp. 11; On the Classification of Rocks, pp. 12; Geological Exploration of the Fortieth Parallel, pp. 32; The Fortieth Parallel Rocks, pp. 20; Atmospheric Action on Sandstone, pp. 2. By M. E. Wadsworth, Harvard University.

Equalizing and increasing our Country's Resources. By John R. Lomas. New Haven, Conn. Pp. 4.

Indian Money as a Factor in New England Civilization. By William B. Weeden. Baltimore: N. Murray. Pp. 51. 50 cents.

Reports from the Consuls of the United States on Commerce, Manufactures, etc. Washington: Government Printing-Office. Pp. 179.

A New Method of recording the Motions of the Soft Palate. By Harrison Allen, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 34.

Handbook for Horsewomen. By H. L. de Bussigny. New York: D. Appleton & Co. Pp. 75. 50 cents.

Life on a Ranch. By Reginald Aldridge. New York: D. Appleton & Co. Pp. 227. 50 cents.

Handbook for the Dominion of Canada. By S. E. Dawson. Montreal: Dawson Brothers. Pp. 335.

Forests and Forestry of Northern Russia and Lands beyond. Compiled by John Croumbie Brown. Montreal: Dawson Brothers; Edinburgh, Oliver & Boyd. Pp. 278.

Illinois State Board of Health. Fifth Annual Report. Springfield, Ill.: H. W. Rokker. Pp. 663.

The Orchids of New England. By Henry Baldwin. New York: John Wiley & Sons. Pp. 159, with Plates.

Report of the Board of Regents of the Smithsonian Institution, 1882. Washington: Government Printing-Office. Pp. 855.

Text-Book of Medical Jurisprudence and Toxicology. By John J. Reese, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 606.

The Amazon. By Carl Vosmar. New York: William S. Gottsberger. Pp. 262.

Nervous and Mental Physics. By S. V. Clevenger, M. D. Pp. 76.

The Wind and the Whirlwind. By Wilfrid S. Blunt. Boston: Benjamin R. Tucker. Pp. 30.

Excessive Saving a Cause of Commercial Distress. By Uriel H. Crocker. Boston: W. B. Clarke & Carruth. Pp. 40. 50 cents.

Elements of Analytical Geometry. By Simon Newcomb. New York: Henry Holt & Co. Pp. 356. $1.50.

Diseases of the Throat and Nose. By Morell Mackenzie. Pp. 550. $3.

Electrical Appliances of the Present Day. By Major D. P. Heap. New York: D. Van Nostrand. Pp. 287.

Fallacies in "Progress and Poverty." By William Hanson. New York: Fowler & Wells Company. Pp. 191. $1.

Cholera and its Preventive and Curative Treatment. By D. N. Ray. New York: A. L. Chatterton Publishing Company. Pp. 128.

Wonders and Curiosities of the Railway. By William Sloane Kennedy. Chicago: S. C. Griggs & Co. Pp. 254. $1.25.

Formation of Poisons by Micro-organisms. By G. V. Black, M. D., D. D. S. Philadelphia: P. Blakiston, Son & Co. Pp. 178. $1.50.

Manual of Biblical Geography. By the Rev. J. L. Hurlbut, D. D. Chicago: The Continental Publishing Company. Pp. 158. $4.50.

Essay on Hamlet. By Professor C. C. Schaeffer. Philadelphia: Charles, Brother & Co. Pp. 25, with Plate.

"Journal of the Academy of Natural Sciences of Philadelphia." Second Series, Vol. IX, Part I. Pp. 154, with Plates.

POPULAR MISCELLANY.

The Warmest Month.—M. E. Renou remarks, in the "Annuaire" of the French Meteorological Society, that throughout the northern temperate zone the maximum of temperature occurs, as a rule, in July. In the corresponding zone on the other side of the equator the maximum comes in January. Between these two zones, or at the equator, the epoch of maximum falls at various dates, according to the storms that rule in the region. They are not so important there as in the other regions, for the difference between the coolest and the warmest month is little at the most. A curious law seems to prevail in the distribution of the maximum. In North America the warmest month is almost universally July; but in the southern regions of that continent it occurs in August. In the Antilles it may be looked for in September, and at Cayenne in October. Passing through South America, before reaching the latitude where it comes in January, we find countries where it occurs in November and then in December. The maximum is found in January through all the southern part of that continent and in Chili. In Peru it occurs in March; there is, therefore, a region between Peru and Chili where it must be looked for in February. North of Lima it is found in April, and farther north in May. Finally, it comes in June as we approach Sonora, and in July in California, where we are brought back in the returning circle to our starting-point. Between Cayenne and Peru we shall evidently find places in which the maximum moves from October into November, etc., and at last into March. In the Gulf of Mexico we may also remark a rapid variation in the time of the maximum temperature as we go from east to west. A similar distribution, marked by the same peculiarities, is noticeable in the Old World. The march of the temperatures of both continents is marked by the analogous phenomena of a shifting of the month of the maximum from July to January in going from north to south on the eastern side, and from January to July in returning from south to north on the western side of the continent. The most rational explanation of the difference presented by the eastern and western coasts is to be sought in the differences in their positions in relation to the seas and to the distribution of storms.

The Earthquake of August 10th.—The Northern Atlantic section of the United States was disturbed on Sunday afternoon, August 10th, by a very distinct earthquake-shock, which, taking place in the city of New York, at about seven minutes past two o'clock, lasted for some ten or fifteen seconds. The shock was felt all along the seaboard from North Carolina to Maine, through a district of country about six hundred miles long and two hundred miles wide, the most distant point from the ocean where it was remarked being at Titusville, Pennsylvania. Its greatest force appears to have been along the Long Island and New Jersey coasts. The statements of the time of the observation of the shock vary some seventy-five seconds as between Boston and New York, so as to show that the general direction of its progress was from north to southwest. It was not accompanied or preceded by any observable peculiarities in atmospheric phenomena. No damage appears to have been done by it anywhere, beyond the occasional fall of a brick from a dilapidated chimney or the shaking down of some article that was not securely fastened, although the nervous excitement it occasioned appears to have been fatal to a few persons. At Boston, the signal-officer, taking his ease in the highest building in the city, was shaken off from his lounge. At Seabright, New Jersey, the railway-station was shifted to one side, with a "shaking up of the contents"; and other trifling incidents of no worse character were remarked in various places.

A Destroyer in the Spruce-Forests of Maine.—According to accounts of observations published in the third "Bulletin" of the entomological division of the Department of Agriculture, the ravages of the spruce-bud worm (*Tortrix fumiferana*) have been extensive and destructive in the coast forests of Maine west of the Penobscot River. The damage appears to have reached only a few miles inland from the coast, but the belt in which it has prevailed is marked by extensive masses of dead woods. The trees are attacked in the terminal buds, which are eaten away, and, when that is done, the case is hopeless. Tho fatal character of the attack is owing to the fact that the spruce puts forth but few buds, and those mostly at the end of the twigs, and, when these are destroyed, it has nothing on which to sustain the season's life. The attack is made in June, when the growth is most lively, and just at the time when the check upon it can produce the most serious results. The larches are also attacked by a saw-fly, but with results that are not as necessarily fatal as in the case of the spruce. They are more liberally provided with buds, some of which may escape and afford a living provision of foliage. The larch, moreover, sheds its leaves in the fall, and is in full foliage before its enemies attack it. Hence, while the spruce and fir succumb to the first season's assaults, the larch can endure two years of them.

The Greely Arctic Expedition.—The vessels sent out for the relief of Lieutenant Greely and his Arctic Expedition returned to St. John's, Newfoundland, July 17th, with the report that they had, on the 22d of June, rescued from their quarters in Camp Clay, Cape Sabine, near the entrance to Smith Sound, seven of the members of the expedition, the other eighteen members having died during the present year, of starvation and exposure. One of the rescued men, Sergeant Elison, died a few days later, after the amputation of his frozen feet. All the records of the expedition were saved, and are to be published. They show that its work was of the most creditable character, and was fruitful in scientific results. Lieutenant Greely's party was sent out by our Government in 1881, as one of a series of International Arctic Expeditions, on the plan suggested by Lieutenant Weyprecht, of the Austrian service, for establishing permanent stations as far north as possible, whence advance parties might be sent farther toward the pole. In the summer of 1882 it established a station at Fort Conger, north of Lady Franklin Bay, near the eighty-second degree of latitude, which it abandoned in August, 1883, to come down to Cape Sabine. Of the exploring parties sent out, one, under Lieutenant Lockwood, reached in Lockwood Island the highest latitude yet attained—83° 24·5′ and longitude 40° 45′, and went a short distance beyond. From a height of two thousand feet, Lieutenant Lockwood discerned in the northeast Cape Robert Lincoln, latitude 83° 35′, longitude 38°. Lieutenant Greely, exploring Grinnell Land, discovered Lake Hazen, some sixty miles by ten miles in extent, and ascended Mount Arthur, five thousand feet high. In a subsequent exploration by Lieutenant Lockwood and Sergeant Brainerd, Grinnell Land was found to be bounded by a water, named Greely Fiord, across which was discerned another land, to which the name of Arthur Land was given. The northern and southern parts of Grinnell Land appear to be covered with ice-caps, between which is a belt of open country some sixty miles wide. Hayes Sound was found to extend some twenty miles farther to the west than is shown on Sir George Nares's chart. The lowest temperature observed was 61° below zero. Animal life was abundant around Fort Conger, but scarce on Cape Sabine. The details of the sufferings and privations to which the party were exposed on Cape Sabine, in consequence of the failure of the supply expeditions to deposit stores of provisions where they were expected to be found, are extremely painful.

Relation of Springs and the First Settlements of a Country.—At the recent Conference on Water-Supply, held by the Society of Arts in connection with the London Health Exhibition, Mr. W. G. Topley read a paper showing how the location of the early settlements in England was determined by facility of access to water. The influence of this condition in attracting settlement to the shores of rivers, lakes, etc., is well known, but Mr. Topley showed also that the law operated with force in the case of the less imposing distribution of springs, and how long lines of early villages could be found situated along lines of territory where well-digging is practicable. Springs occur near where a pervious bed overlies or underlies an impervious bed, or where a valley reaches down to the level at which the rock is saturated with water. A soil which allows water to sink into it is a dry soil, and is, therefore, suited for habitation and for agriculture. Hence the main conditions which favor the settlement of a district are found in the same soil, or along the outcrop of the same bed. We thus see that geological structure controls the distribution of population, not only in such great features of the earth's surface as mountain-chains, plains, and valleys, but also in minor divisions of the district. The outcrop of a narrow band of porous rock beneath wide beds of clay is strongly marked by the occurrence of a long line of villages, each of which obtains its water from shallow wells or springs. When rocks rise from beneath a covering of clay, there are often springs at the junction. While the early settlements in England were nearly always controlled by these circumstances, relating to the distribution of springs, the later development of special towns and districts has depended upon a variety of conditions, many of which have become very complicated.

Construction of Stretchers and Ambulances.—Dr. Robert Lawson has given some valuable hints on the construction of stretchers and ambulances for the removal of the sick and wounded. It is most desirable in them to avoid or mitigate as far as possible inequalities and roughness in motion. Field-stretchers are liable to swing with the swaying from side to side of the bodies of their bearers and to a regular series of jolts. With each step he takes, the porter bends his body to the side on which a foot is touching the ground to maintain his equilibrium, and his burden follows him. The swinging may be diminished by causing the bearers to walk out of step, so that the sway of one to the right may be neutralized by the sway of another to the left. The jolts are consequent upon the shortening of the height of the bearer as his body bends over when the foot is set forward to make the next step. They are mitigated by shortening the length of the pace; a difference in height of three and a half inches, with a pace of thirty inches, may be reduced to about an inch and a half if the pace is shortened to twenty inches. If the stretcher-poles are round and too slender, the jolt is aggravated by their bending, sometimes by as much as two inches. A stretcher with square-cut poles, three square inches in section, weighed twenty pounds, and was found remarkably free from vertical oscillation, and easier to carry than one with lighter poles. The sacking of the stretcher should be six feet long. Legs should be attached to the frame, so that the couch shall be lifted above the ground when at rest. Ambulances should be made to receive the stretcher, and not compel a transfer. With a truck of five feet two inches, they may be contrived so as to admit two field-stretchers one foot eleven inches wide, and leave space for a partition an inch thick, to prevent the occupants from rolling. The motion of ambulances, at least in injurious directions, should be reduced as much as possible. Springs inside of the wagon, in addition to the ordinary springs, for the stretchers to rest upon, have been tried, but they have been found to produce discords in motion through the inequality in the rhythm of their vibrations, causing pain and injury to the patient. The wounded man is "most advantageously situated when he is subjected to the motion of the body of the wagon alone, at a point as near the floor as can be managed, and the ease of this motion can only be adequately provided for by careful adaptation of the springs to the weight they have to carry."

The Electric Light and Health.—"The Bearing of Electric Lighting on Health" was the subject of an essay by Mr. R. E. Crompton and a conference at the recent Health Exhibition. Mr. Crompton held that the conditions of health were not so good in any kind of artificial light as in daylight. Even the electric light, diffused, is deficient in intensity and inferior to daylight. All artificial lights except the electric contaminate the air. At the twelve-candle standard, coal-gas vitiates 348, paraffine-oil 484, composite candles about 650, and tallow-candles 933 cubic feet of air per hour, but the electric light none. The amount of heat produced in the same time by the same lights is represented respectively by the numbers 279, 362, 383, 505, and 14. The criticism of the glare of the electric light is not just; we are not supposed to look at it. The real test is the intensity of the diffused light. The steadiness of the incandescent electric light gives it a great advantage over all others, and the arc-lights are also being made more steady. The eye-sight of the men in the British General Post-Office has been greatly improved since the electric lights were introduced. Other advantages of the electric light are the greater pleasure it gives, its greater convenience, and its absolute safety.

How State Monopoly of Railroads works.—An interesting view of the operation of the state monopoly of railroads in India was given a short time ago by Mr. J. M. Maclean before the British Society of Arts. Of 12,655 miles of railroad which were open in India on the 31st of March, 1883, 5,037 miles had been built by the Government, and 7,618 miles by companies working with the assistance or under the guarantee of the Government. Thus, the whole railway system of the country is in a very large measure controlled by the state. In the case of the guaranteed lines, the Government has contracted to pay the shareholders an annual interest of five per cent, paying two and a half per cent every six months. This arrangement is so carried out in practice as to work very unevenly as between the Government and the shareholders. If the net earnings of any line fall below the stipulated rate in a particular half-year, the Government has to make good the deficit, while, if the earnings are in excess, the surplus is divided between the Government and the shareholders. Now, in Western India, the profits of the railroads all come in one half of the year; and while in this half the roads may earn a surplus of profits amounting to hundreds of thousands of pounds, of which the Government gets a half, in the other half year the earnings may not be enough to pay the guaranteed interest, and then the Government has to bear the whole burden of the loss. During 1882-'83, the Government actually lost £231,380 on the guaranteed lines, while the shareholders pocketed a handsome profit in interest and surplus; and the state was saved from absolute loss only by the excessive profits it made out of a single one of its own lines. The system thus leads to the habit of regarding all the railways as one great property, and of seeking to make up for the losses that may be incurred on one set of lines by the more than legitimate profits which there may be opportunity to make on another set. The Government has thus become accustomed to the idea of maintaining its military and administrative lines at the expense of the commercial ones. The latter lines need enlargement to accommodate their increasing business, and would amply pay for it, but the state needs the money they furnish it, and which ought to be applied in that way, for the maintenance of its unproductive lines, and has adopted a penurious policy toward its productive ones. Whenever a complaint is made, or a proposition having in view a more liberal policy is agitated, a half-dozen boards and sets of officers in India and England "straightway begin to play an elaborate and interminable game of battledoor and shuttlecock with the public interests. Any suggestion that is offered is minuted upon, referred, transferred, and generally knocked about, till the authors of it are ready to abandon it in despair." When called upon to interfere, the Government "is always, perhaps unconsciously, influenced by the thought that, if it sanctions increase of expenditure or reduction of rates, it may diminish its share of surplus profits. Hence the unwise parsimony which leaves main lines insufficiently supplied with rolling-stock to meet any sudden expansion of traffic." Our civil war was over before the Peninsular Railway was supplied with engines and cars enough to take away the cotton which choked all of its stations. The stations are glutted with wheat awaiting transportation to such an extent that the peasant dreads a good crop for fear that it will add to the quantity he must lose, because it takes on the average about five years to get the facilities that are needed on the instant. The Government hesitates when it should act, because it grudges an expenditure of capital, which, while it is comparatively insignificant and sure to bring ultimately a large return, means for the present a temporary reduction of profits on a lot of railroads, the most of which are losing ones.

Influence of Occupation on Physical Development.—The data obtained by the Anthropometric Committee of the British Association reveal some curious facts respecting the influence of occupation upon physical development. As a rule, the inhabitants of the country are taller and heavier than those of the large towns; but London is an exception, and seems to exert an attraction that draws in the more vigorous part of the country population. The metropolitan police, as a rule, are nearly as tall as the laborers of Galloway—the tallest of Britons—and twelve pounds heavier. The members of the Fire Brigade, who need not be so solid, but are expected to be active, are two and a half inches shorter and twenty-five pounds lighter than the policemen. Athletes average five feet eight and one third inches in height, and only about one hundred and forty-three pounds in weight; from which it is inferred that the majority of the population carry from ten to twenty pounds weight which they would not carry if they were in the highest physical condition. The Fellows of the Royal Society—a class of prominent intellectual gifts—are among the tallest of the race, averaging five feet nine inches and three quarters. The criminal class are forty-five pounds lighter than the police and four inches and a half shorter; and they are eighteen pounds lighter and two inches shorter than the average of the population. Lunatics are about as short as the criminals, but heavier. In men of the same occupation belonging to different races, the influence of race appears to be predominant over that of occupation.

Climbing the Himalayas.—Mr. Graham, an Englishman, with the help of two Swiss mountain-guides, has recently made an attempt to ascend some of the lofty peaks of the Himalayas. Starting from Nynee Tal, he found his first difficulty, and not an insignificant one, to be to get to the mountains. They stand far back, and are approachable only through valleys occupied by large streams. The first attack was made upon Dunnagiri, which is 23,184 feet high. In order to reach it they had to climb over two peaks 17,000 and 18,000 feet high, and then, after a five days' march, they camped on a glacier at the height of 18,400 feet. On the sixth day they reached a height of 22,500 feet, when, a snow-storm coming on, they were compelled to retreat, after they had come in sight of their goal. Mr. Graham observes that the peaks of the Himalayas, as a rule, are considerably steeper than those of the Alps; and he is convinced that breathing is no more difficult at the height he reached than at 10,000 feet lower down. The party also ascended the Kang La, 20,300 or 20,800 feet high, and a new mountain, 23,326 feet high, which was called Mount Monal, from the number of birds of that name seen upon its slopes.

Volcanic and Cosmic Dusts in Submarine Deposits.—Messrs. John Murray and A. Renard have taken advantage of the phenomena attending the eruption of Krakatoa last year for the extension of their studies in the accumulation of volcanic *débris* and cosmic dust in deep-sea deposits. Mr. Murray had already shown, before the Royal Society of Edinburgh, in 1876, that volcanic materials play the most important part in the formation of these deposits, and how they may have been furnished by the decomposition of pumice and the settling of incoherent volcanic ejections. Rounded fragments of pumice are collected on the surface of the sea in regions far from coasts, and at certain points on the bottom of the ocean the greater part of the deposit is composed of vitreous splinters derived from the trituration of such stones. The eruption of Krakatoa in a few hours filled the Bay of Lampong with about 150,000,000 cubic metres of ejected matter. Floating fragments from this source were collected on the surface of the water with their angles rounded off, and showing, as the only asperities upon their surface, crystals and fragments of crystals projecting beyond the mass of vitreous matter. The crystalline fragments and volcanic minerals can not be identified with certainty when reduced to their finest state, as in the deep-sea deposits; for in that condition they lose all their characteristics of form and optical properties. The case is different with the vitreous particles derived from the pumice, or included in the volcanic ash, whose characters remain constant to the extreme limits of pulverization. The results of the study of the micro-structure of the vitreous particles from Krakatoa, which are described in full by the authors, can be applied with most perfect exactitude to the volcanic dusts, which have been determined as such, in the deep-sea deposits. The latter have, however, only partly been derived from the pulverized ejections of a volcano, but more from the trituration of floating pumice; but it is hardly possible to trace the differences between the two. The minerals that can be determined in the ashes of Krakatoa are the same as are almost always found in the deposits along with the splinters of glass. It is not to be expected that the volcanic dusts found in all the deep-sea deposits shall be uniformly identical. In the first place, they may originate from *magmas* of varying characters, according as they come from volcanoes in different parts of the world. The matter also goes through a sifting process as it is carried through the air and in settling in the water. The vitreous particles, being lighter, are carried farthest from the volcanic center, and are longest in reaching the bottom. The fact has been illustrated in the case of Krakatoa that, in proportion as the ashes are collected at a greater distance from the volcano, they are less rich in minerals, and the quantity of vitreous matter predominates; a submarine tufa-deposit in the center of the South Pacific, in which the particles are graduated from the bottom up, illustrates the difference in the facility of settling. The evidence that has been adduced in favor of the hypothesis of a circulation in the atmosphere and a settling upon the earth of cosmic dusts is doubted by some, who have suggested various possibilities of an earthly origin for the particles described as cosmic. According to our authors, however, many of the doubts are at once removed by a statement of the circumstances under which cosmic spherules are formed in deep-sea deposits, and when the association of the metallic spherules with the most characteristic bodies of undoubted meteorites is shown. Cosmic particles are found in most abundance in deep-sea deposits at distances from land that preclude the supposition of their having originated in inhabited countries, and their form and character are essentially different from those of bodies collected near manufacturing centers, with which the attempt has been made to associate them. After describing some of these spherules, with graphic illustrations of their structure and composition, the authors express the belief that they have presented enough evidence to show that in their essential characters the spherules are related to the *chondres* of meteorites, and are formed in the same manner.

Manganese in Plants.—M. E. Maumené has found manganese in wines and in a considerable number of vegetable and animal products in which it had hardly been supposed to be present; and now announces, as the result of his latest investigations, that he has detected it in a great many plants. Wheat contains not less than from $\frac{1}{18000}$ to $\frac{1}{8000}$ of metallic manganese, and rye, barley, rice, and buckwheat have also yielded considerable quantities of it. A little of it may be found in the potato, and more in the beet, the carrot, beans, peas, asparagus (principally in the green part), sorrel, wild chicory, lettuce, parsley, and in many fruits. It occurs in large proportions in cacao and the coffees, and in tea there are five grains of the metal to one kilogramme of the leaves. Tobacco is quite rich in it, as are also a variety of other plants, including some forage and some medicinal plants. The human system refuses to absorb it, and whatever of it may be introduced with the vegetable food in which it is present is eliminated with the fecal matter.

Gutta-Percha.—The earliest known mention of gutta-percha is by John Tradescant, who, in the catalogue of his "Rarities," preserved at South Lambeth (1656), mentions "plyable mazer wood," which, "being warmed in water, will work to any form." The earliest introduction of the gum to the commercial world is due to Dr. William Montgomerie, of the East India Company's service, who experimented upon it at Singapore, in 1822, and recommended it to the Medical Board of Calcutta in 1842 as a substance useful in the making of surgical splints. The name *gutta* is a Malay word, signifying gum, or juice. The gum is derived from the middle layer of the bark of a number of trees of the order *Sapotaceæ*, to which order also belong the sapodilla-plum and the vegetable-butter trees. The principal source is the *Dichopsis gutta*, a plant which was described by Sir W. J. Hooker, in 1847, as *Isonandra gutta.* Dr. De Voiese, of the Dutch Government service, names eighteen species that yield the gum. The *Dichopsis gutta* is found in the Malay Peninsula, Sumatra, Borneo, and throughout the Malayan Archipelago generally. It grows to a height of from sixty to eighty feet, with a diameter of from two to five feet. The leaves are inversely egg-shaped (oblong in one variety) and entire, pale-green on the upper side, and covered beneath with a reddish, shining down. The flowers are arranged in clusters of three or four in the axils of the leaves. The fruit is a small oval berry. The gutta, as it flows from the tree, is of a grayish color, at times somewhat roseate in hue. When cast or rolled it assumes a fibrous structure, and acquires a tenacity in a determinate direction. At a temperature of from 32° to 77° Fahr., it has as much tenacity as thick leather, but is not at all elastic, and is less flexible than leather. In water, toward 120° Fahr., it softens and becomes doughy, although still tough; at from 145° to 150° Fahr. it becomes soft and pliant, assuming the elasticity of caoutchouc, but becomes again hard and rigid on cooling. It is highly inflammable, burning with a bright flame, and has marked electric properties.

Courtesy and Sagacity of the Duck.—A correspondent of the London "Spectator" extols the courtesy and sagacity of the duck. In illustration of the former trait, he tells of a "solitary, little, old bantam hen" he had among some fifty or sixty head of ducks and fowls, which became blind, or nearly so, and had to "sulk" in the dark to escape the persecutions of her mates. "Here," he says, "she might, perhaps, have starved, but for the constant and sympathetic attentions of a duck. Twice daily, every day so long as the poor bantam lived, some three weeks, this good Samaritan, in the form of a duck, was observed to fill her capacious beak with from twenty to thirty grains of barley, with which she proceeded to the fowl-house, and there deposited her store immediately in front of the bantam." Another anecdote is given in evidence of the sagacity of the duck. "I had five Aylesbury ducks, with a number of fowls. The lord of the yard, a most despotic chanticleer, would never suffer the ducks to feed with his family and friends when, at the regular meal-times, the grain was scattered for their common use. Ferociously, and without pity, he drove them from the ground. This had been going on for many weeks; and one day, at the twelve-o'clock repast, the act of expulsion was performed as usual. I was present, and saw the discomfited ducks retire to a corner of the yard. There they evidently held a conference. Having been so engaged some five minutes, they proceeded with deliberate and resolute air, in single file, as is their wont, toward their oppressor. Having reached the tyrant, they surrounded him, each duck turning his posterior toward the enemy, and with concerted action fairly hustled him clean out of the yard. To see the surprise of the cock, as he jumped from side to side to avoid the pressure of the attacking party, was ludicrous in the extreme. The victory was complete; from that hour the ducks were never again molested."

Attractions and Repulsions of Dust.—Mr. John Aitkin has recently performed some experiments illustrating the formation of clear spaces in dusty air. His apparatus consisted of a dust-box blackened inside, having a glazed front, and provided with a window on one side. Condensed light was admitted through the window from a dark-lantern. Dusts were made by chemical processes or from calcined magnesia, lime, or charcoal, and were stirred up by means of a jet of air. A round tube was introduced into the box and the dust stirred up, when it was observed that the dust came in close contact with the top and sides of the tube, but that below it a space was clear. This disposition of the dust was found to be an effect of gravitation, under which the falling particles did not reach the space immediately under the tube. When a thin plate was inserted vertically in place of the tube, no clear space was formed. No increased effect was observed on lowering the temperature from the normal; but, if a little heat instead of cold was applied to the round tube, the dark space rose and encircled the tube, and the two currents of clear air united over the tube to form the dark plane in the upward current. Heat was furthermore found to exert a real repelling effect on the dust. On heating the vertical metallic plate, the dark plane was formed in the ascending current in front of the plate, beginning with the slightest increase, and growing thicker with the rise, of temperature. With very high temperatures, produced by heating platinum wire in a battery, every kind of dust was found to have a different-sized dark plane; and, as the particles could be seen streaming into the dark space under the wires, it was obvious that these large dark planes were not caused by repulsion, but by the evaporation or disintegration of the particles. The effect of electrification of the hot surface was found to be opposite to that of heat, and dust was attracted to the surface or repelled from it, according as electricity or heat was applied with more force. It was also found that after the dust-particles were electrified they tended to deposit themselves on any surface near them, and electricity proved to be capable of depositing the very fine dust of the atmosphere. The air in a flask was purified much more quickly by means of the electric discharge than it could have been by means of an air-pump and cotton-wool filter. It was shown that a hot and wet surface repels dust more than twice as strongly as a hot and dry one. From this it was concluded that the heat and moisture in our lungs exert a protecting influence on the surface of the bronchial tubes, and tend to keep the dust in the air from contact with their surfaces. It was also observed that dust was attracted to cold surfaces and attached itself to them.

Chinese Plants in America.—Dr. D. J. MacGowan has published some notes on Chinese plants which it may be profitable to acclimatize in the United States. Among the plants he has recommended are several bamboos, the coir-palm, banian, planoconvex turnip, mat-grass, glutinous and red rice, and bitter orange. The trees used for the preparation of varnish form another group. Ningpo varnish is a compound article, the product of two trees; one a kind of rhus, or sumach, which has a wide range of growth, and the nut-oil tree, whence the nut-oil or "wood-oil" of commerce is derived, of which there are two varieties, the hill and the green variety. The varnish is made by combining the juice of the rhus and the nut-oil extract. An important varnish is also made from a wild persimmon, and a similar one is obtained from what appears to be an alga. The *yang-mei*, or tree-strawberry, produces a famous fruit resembling the mulberry, which, it is said, is given a terebinthine flavor by a curious process of grafting on the fir. Lichi (*Nephalin lichi*, *Nsungau*) is a delicious tropical fruit, of which there are between thirty and forty kinds, and is found as high up as the latitude of 30° in Szechuen. Dr. MacGowan also suggests the expediency of experimenting with Chinese water-plants. Among them are the water-caltrap, which bears a valuable fruit; the tuberous water-chestnut (*Ellocharis tuberosus*); the *chico pai*, with celery-like shoots; the *chin tsai*, or water-celery, which is cultivated in floating gardens built on bamboo rafts; the *t'ish-shu*, or iron-tree, "the most beautiful of the *Cycadaceæ*," which is revived, when it grows old, by driving iron nails into its trunk; and the *tiao-lau*, a hanging epidendron, which flowers only when taken from the ground and suspended from a ceiling.

NOTES.

According to the estimates of Mr. J. C. Smock, of New Brunswick, New Jersey, made after a comparison of all the observations, the great glacier of our continent "appears to have covered the whole of New England and Northern New York, and to have filled the Hudson Valley to a depth of at least three thousand feet, as far south as the Catskills, burying the Berkshire Hills, the Shawangunk Mountain range, and the Highlands of Southern New York in its icy folds. Above it stood the higher peaks of the Catskills and the summits of the Moosic Highlands as isolated landmarks, or islands, in the great *mer de glace*."

Professor C. E. Bessey suggests that as the Government has efficiently encouraged the study of the insects injurious to vegetation, and given us an increased acquaintance with the habits of these pests, and hints as to the way they are to be dealt with, it might do another service quite as valuable to agriculture by promoting the investigation of the parasitic fungi which injure and often destroy farm and garden crops. The destruction they effect is almost as great as that occasioned by insects.

The International Forestry Exhibition was opened at Edinburgh on the 1st of July, by the Marquis of Lothian, who spoke of the importance of education in forestry to the British nation. The United Kingdom, he said, had more property in the world than any other nation, but in this respect it was behind the others.

Professor Gabriel de Mortillet is about to begin the publication of a new fortnightly journal of the anthropological sciences, to be called "L'Homme." He will be assisted by a body of specialists as department-editors, and will contend actively for the recognition of anthropology as a science, the peer of the other sciences.

Captain James B. Eads, the American engineer, has received the Albert medal of the British Society of Arts. He is the first American on whom this distinction has been conferred.

It is generally understood that the hair and nails grow faster in hot weather than in cold, but few probably are aware that any temperature of the weather can impart so great a stimulus to the growth as Colonel Prjevalsky, the Russian traveler, says the Central Asian heat did during his journey in those regions. In June the ground and the air became excessively hot, so that it was impossible to travel in the day-time. The hair and beards of all the party grew with astonishing rapidity, and, strangest of all, some youthful Cossacks, whose faces were perfectly smooth, all at once developed quite respectable beards.

M. Olzensky has liquefied hydrogen at a temperature of $-371°$ Fahr. In this condition the element appears to lose the metallic affinities which it manifests in the ordinary state, and assumes qualities of mobility and transparency more like those of the hydrocarbons.

Experiments made by Dr. William McMurtrie, which are described in "Bulletin No. 3" of the Entomological Division of the Department of Agriculture, go to show that the silk fiber from worms fed exclusively upon the Osage orange is somewhat finer, and, on the average, equal in strength to that obtained from mulberry-fed individuals.

Gabriel Gustav Valentin, till 1881 Professor of Physiology in the University of Berne, died May 24th. He was an excellent teacher and a profound physiologist, and was the author of several scientific works on physiological subjects, among them two in Latin. His "Text-Book of Physiology" was translated into English by the late Dr. Brinton.

Madame de Colbert has intrusted the French Academy with some valuable manuscripts of her grandfather, Laplace, which she has recently discovered, on condition that they shall not be opened till 1930.

Mr. H. W. Eaton, of Louisville, Kentucky, has described, in "Science," a female negro child which was born in that city in March, having what appeared to be a rudimentary tail. The tail was visible as a "fleshy peduncular protuberance," about two and a quarter inches long, and measuring an inch and a quarter around at the base, closely resembling a pig's tail in shape, but showing no sign of bone or cartilage, situated about an inch above the lower end of the spinal column. It had grown about a quarter of an inch in eight weeks.

Professor James Hall has been elected a corresponding member of the French Academy of Sciences, mineralogical section, in place of the late Professor J. Lawrence Smith.

Among the important enterprises undertaken by the United States Coast and Geodetic Survey are the measurement of the arc of the thirty-ninth parallel, which is nearly 50° long, and of the meridian of the ninety-ninth degree of longitude, which stretches nearly 23° through the United States, and may be extended north and south to a length of 50°. This will furnish two lines of the highest value in solving the great problem of the figure of the earth.

Grape-seeds contain about eighteen per cent, by weight, of oil, which is largely extracted at Modena and other places in Italy, and used for purposes of illumination.

OBITUARY NOTES.

Ferdinand von Hochstetter, the German mineralogist and geologist, is dead, in the fifty-fifth year of his age. His earlier scientific work was done in New Zealand, when, having left the Novara expedition, he began geological investigations about 1857. He was afterward Professor of Mineralogy and Geology in the Polytechnic Institute of Vienna, and President of the Vienna Geographical Society. Besides works relating to the topography, geology, and palæontology, and the boiling springs of New Zealand, he was the author of books on the geology of Eastern Turkey and the Ural, and of various popular publications.

The July death-list contains the names of three of the scientific men of Sweden: the geometrician, August Pasch, who was fifty-one years old; the botanist, Dr. Lar Magnus Larsson, of the high-school at Carlstad, sixty-two years old; and the chemist, Professor Sten Stenberg, who died in the sixtieth year of his age.

The death is announced of the Abbé François Napoléon Marie Moigno, at Saint-Denis, France, at the age of eighty years. The abbé was of Breton birth, and was educated for the Church. Displaying a taste for science, the Jesuits made him a teacher of mathematics in one of their seminaries. In 1861 the superior of the order directed him to suspend the publication of a work on the calculus which he was preparing, and assigned him a chair of Hebrew and History. He preferred scientific studies, and left the order rather than give them up. He became a scientific contributor to the journals, and founded the "Cosmos," which eventually gave place to the journal "Les Mondes." He was author of books on electric telegraphy, the stereoscope and the saccharimeter, modern optics, a course in popular science, analytical mechanics, several volumes of "Scientific Actualities," and "The Splendors of Faith."

Dr. Erasmus Wilson, a well-known English medical writer, died August 9th, in the seventy-sixth year of his age. His specialty was diseases of the skin, and he founded chairs of Dermatology at the College of Surgeons and at Aberdeen, as well as the Museum of Dermatology at the former institution.

Professor Karl Richard Lepsius, the oldest Egyptologist in Europe, died in Berlin in July last. He was born in 1810; having studied philology at the German universities, he gave his attention to the examination of the Semitic and other alphabets, and of the hieroglyphic alphabet; published studies of various important Egyptian tablets and inscriptions, and of the "Book of the Dead"; and went upon his scientific expedition to Egypt in the fall of 1842. He published his "Einleitung," or "Introduction to Egyptian Chronology," in 1849; his great "Denkmaler," or portfolios of all the Egyptian monuments, between 1849 and 1860; his "Königsbuch," or lists of kings, in 1858; and his "Standard Alphabets," in 1860. He began the publication of a periodical devoted to Egyptology and archæological research in 1864; and he was the discoverer and the translator of the celebrated trilingual "Decree of Canopus."

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