ESTABLISHED BY EDWARD L. YOUMANS.

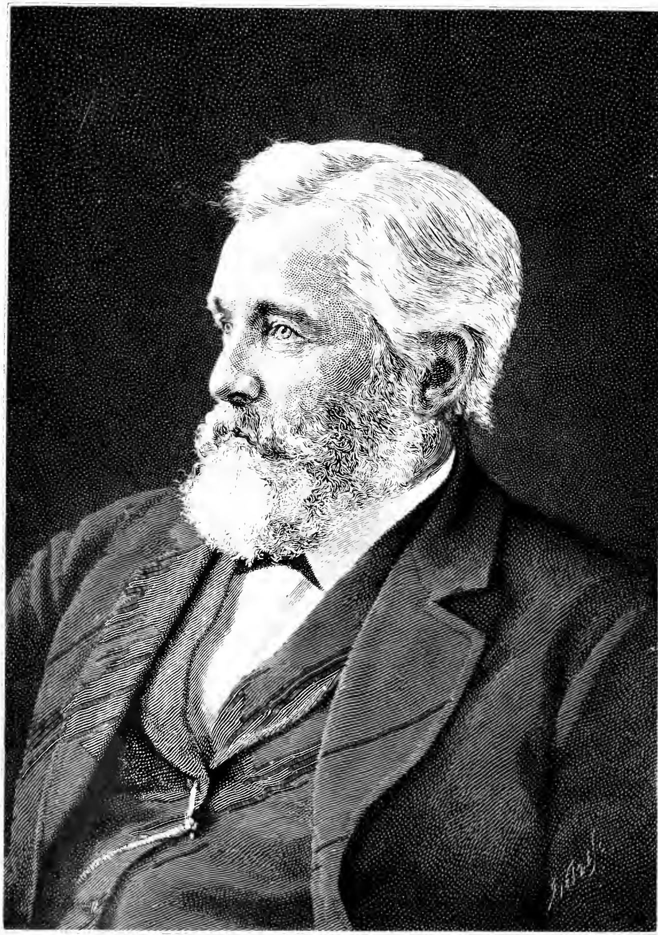
THE POPULAR SCIENCE MONTHLY.

EDITED BY WILLIAM J. YOUMANS.

VOL. XXXIV.

NOVEMBER, 1888, TO APRIL, 1889.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.
1889.



EDWARD ATKINSON.

THE

POPULAR SCIENCE MONTHLY.

NOVEMBER, 1888.

THE EFFECTS OF PROTECTION.

By CHARLES S. ASHLEY.

THE people of the United States are this year applying themselves with a concentration very rare in great masses of men to the problem of tariff revision. It is inevitable that in a nation of so fresh and independent a spirit the claims of authority and scientific results should not receive any great recognition; and I, for one, rejoice that the people rely upon themselves and their own judgment and experience, rather than on the theories, however respectable, of eminent writers. We are therefore brought face to face with the question, What has been our experience in the matter? What have been the effects of protection in this country? It is especially interesting to examine the question from a strictly practical point of view, because this is the chosen battle-ground of the defenders of the existing system.

Free trade is an extension of the practice of our daily lives. We each of us buy in the cheapest market what we wish to buy, and sell our wares or our labor where we can get the most for them. I do not make my own shoes, but employ the great length of time which it would take me to make them in doing something which enables me to buy several pairs and other things as well. Instead of making my own shoes (thus, in protection phraseology, "protecting" my own "labor"), I buy my shoes of a neighbor, and the Government does not attempt to prevent me or to tax me for so doing. Even my neighbor does not himself make the shoes which he sells me. He does not undertake to protect *his* labor, but buys of a wholesale house in New York, which in turn buys of a Lynn manufacturer. The result of all these complicated transactions going to give me a pair of shoes is, that I get them at an equivalent of a very moderate amount of work, instead of by a great deal of direct exertion and personal sacrifice. So, too, the citizens of Chicago do not attempt to raise their wheat in their own "back yards," but send their money into distant parts and buy it; while, on the other hand, the farmers of whom they buy do not attempt to make their own clothing, their furniture, or even their own flour. They buy them at Chicago. They do not think it good economy to expend $100 worth of their own labor for what costs but $10 in Chicago, but wisely prefer to use it in creating what will bring $100 in Chicago. So, too, rising in the scale of comparison, Iowa and Kansas do not "protect" themselves against New York and Massachusetts, nor do they attempt by legal means to "foster industries" which exist in the latter States. The national Constitution, fortunately, forbids such a course; and, as a party, the protectionists have not yet taken it on themselves to say that a "protection" policy would be for the advantage of the granger States as against the manufacturing States. But the moment we come to that imaginary line known as the national boundary, this simple and beneficent process ceases. The farmers of Manitoba would naturally buy their clothing, furniture, tools and machinery, and much of their food, at Minneapolis and St. Paul. The merchants of those cities would like to sell to the Manitobans, but the two Governments prevent it. Only last year the Manitobans had a very good potato-crop, while that of Minnesota was a failure; and, on the other hand, fruit was plenty in Minnesota and scarce in Manitoba. It would have been natural to have sold American fruit in Manitoba, and to have brought back potatoes. But no; protection "protected" the people of Minnesota from potatoes that year, and the Manitobans, as they tried to imagine that their superfluous potatoes were apples and pears, doubtless consoled themselves with the idea that they were growing rich, because no Yankees were selling them fruit and taking their money away.

It is useful to recur to these every-day facts of universal experience in order that we may have the great and complicated question before us in its simplest elements. I think the homely illustrations I have used at the outset will lend certainty and significance to the results of a survey of the effects of protection in the larger and vaguer field of our national life. Let the reader keep in mind the consequences which would ensue if I did not buy my shoes of a neighbor—the poor shoes I would have, and the great labor with which I obtained them. Let him imagine the result of the Chicago people attempting to raise their wheat in their own "back yards," or of the farmers of Iowa refusing to buy any cloths or machinery not produced in their own neighborhood. Let him imagine the poverty and want which would prevail in the frontier States if from the moment of settlement they adopted the policy of prohibiting all these importations from the East, by which they save labor and build up their country. He will then be in a position to see, by analogy, the evils which have followed in the train of protection, even in this country of vast extent and limitless resources. And, on the other hand, he will not fail to see the analogy between the success of that natural system which prevails in the United States, and is practiced by each of us in our private capacities, and the policy of industrial liberty which a few nations have been led to adopt.

The plain primary effect of a tariff and its main purpose, so far as protection is concerned, is to raise the price of the article imported by the amount of the duty. It may be, and to some extent doubtless is true, as claimed, that internal competition afterward reduces the market price. But the primary effect is manifestly as stated, if the article continues to be imported. This increase of price necessarily is borne entirely by the consumers, except in certain special cases (as where the supply market is very small in extent, and where prices would consequently rise very fast with the unfettered demand of the American consumers), since we have no means of forcing foreigners to ship goods here except at the same rates which they would be willing to sell for if there were no tariff. But, of course, it may be that the tariff is so high that the imports practically cease, and the American market is supplied by American producers, though at an enhanced cost over what would have been necessary to pay, with the world to choose from. In this case the consumer, of course, still pays this enhanced price, whether or not, as the protectionist contends, he somehow gets it back. With these few points in mind we will proceed to determine in a few particulars, as nearly as may be what this country has actually paid by reason of our high tariff. It is greatly to be regretted that materials do not exist to make a complete showing of what the protective features of the tariff have cost the people without benefiting the Government; but a few instances may serve as illustrations, and will faintly indicate the enormous extent of that forcible transfer of wealth from buyers to sellers which has been made by prohibitory tariffs.

The average price of steel rails in this country has for the past twenty years been at least $15 per ton more than in England. There has been a consumption of at least 30,000,000 tons necessary to lay and repair our 156,000 miles of railway. More than two thirds of this amount has been bought at home. The Government has, therefore, forcibly transferred about $300,000,000 belonging to one class of American citizens to another class, by laying an embargo on the business of the first in favor of the second.* In some years the demand for steel has been so great

* In the year 1887 Carnegie Brothers & Company, of Pittsburg, manufactured 192,998 tons of steel rails at a cost of $26.79 per ton, and sold them at an average of $37.12½

that rails have sold for double and even treble the natural cost; but still buyers were forced to buy in the home markets. And the reduction in duty from $28 to $17 per ton was accomplished only in the teeth of vigorous protestations that it would ruin American mills and workingmen. I say nothing of the effect of this tax on railroad building and operation in rendering transportation scarcer and more expensive. But it is probable that a line of railway with which I am connected would by this time have been completed and have been paying handsomely but for the $300,000 additional expense of construction entailed by the protection tariff.

Pig-iron enters into articles used in every house and in every business. It is turned into plows, kettles, and stoves, as well as into vast engines, railway material, building material, and fire-arms. Four million and a half tons of this material were made in the United States in 1882 and sold at an average of $22 per ton. In 1880 the market value reached $40, and in 1886 $17. According to Mr. Wilkeson, this material ought to be marketable at $9 per ton easily, and Mr. Vinton does not think its actual value much more. But making an allowance of $12 per ton as liberal, in fact very liberal, we may say that the people of the United States have paid an unnatural price for this product amounting in all to $45,000,000 in 1882 alone; and, assuming that to have been an average year, we may place the enhanced price of pig-iron to the American people for the past twenty years at the enormous aggregate of $900,000,000.

On lumber it is difficult to make an accurate estimate. But assuming the cut of Michigan in 1880 (4,172,000,000 feet) to have been half the product affected, and to have been enhanced in price to the extent of half the duty, which, in view of the enormous forests of Canada, and the great value of our standing pine, is very moderate, the tariff on lumber has cost the people of the United States $8,000,000 per annum. One peculiarity about this tax, or rather levy, is, that it inures to the benefit solely of a few land-owners in Michigan and elsewhere, who were fortunate enough to get the pine-lands when they were worth $2 per acre.

per ton; making a profit of about $1,158,000 on that item alone of their manufactures. For the making of these rails they paid out in wages $778,075, equal to about 68 per cent of their profits. During the same year the same firm turned out about 30,000 tons of iron and steel beams (used in large buildings, bridges, etc.), at a cost of about $28.02 per ton, and sold them at $66 per ton, through a trust; making a total profit of about $1,150,000, which is 135 per cent. of the total expenses and about seven times the sum paid by them to their labor employed on this product. The exorbitant profit thus made at the expense of the owners and patrons of railways and buildings was rendered possible solely by the high tariff (on rails $17 per ton, or about 75 per cent; on beams, 1¼ cent per pound, or about 102 per cent).—Abridged from the speech of W. L. Scott, in the House of Representatives, May 11, 1888.

Labor does not produce the pine, nor does it gain any great proportion of its market value.*

The American people are clothed very expensively. They import about half their woolen goods, and pay thereon an enormous tax to the Government, amounting in 1885–1886 to $35,600,000. The other half of their clothing they buy of domestic manufacturers, and may be assumed to pay an unnaturally high price to about the same extent. We may say, then, that in twenty years the people have paid a bounty of about $700,000,000 to domestic manufacturers and about the same amount in taxes to the Government.

The average wage of Americans is, as is well known, considerably higher than that of the English; yet Mr. Mulhall estimates that the American works forty-nine days in the year to supply himself with clothing, while the Englishman accomplishes the same thing in thirty-four. This result has been brought about by the wool tariff of 1867, which imposed a heavy duty on an article not made or greatly added to in value by labor, wool, and also on woolen clothing. The history of the effect of this duty is interesting and even ludicrous. Foreign wools are needed to mix with American wools to make good cloth. Accordingly, when the tariff was put on wool the manufacturers found that the people would not buy the high-priced product, but bought foreign goods. Then they began to adulterate their woolen goods with shoddy and cotton. But, in spite of everything, the woolen industry was depressed, and the price of wool refused to go up.† Some of them saw the moral; but only the other day I was talking with one who expressed his opposition to the Mills bill by saying, "We do not think it will hurt our business; we *know* it." On being asked if he did not think free wool and a duty of thirty-eight per cent a fair equivalent for the present duty, he started and clearly showed he had no accurate idea of what the

* Soon after the duty was put on pine-lumber the pine was advanced $1 per thousand feet. Seeing this, the men at the camps in Michigan thought it was a good time to ask for a slight increase in pay, inasmuch as the tariff was, they were assured, for their benefit. They asked an increase from $1.50 to $1.75 per day, an increase equivalent to perhaps 5 per cent of the increased profit. Thereupon they were all dismissed. Canadiaus were imported at $1.25 per day, and were only worked three fourths time at that. Great is "the American system."—"Indianapolis Signal" (Labor paper).

† After the enactment of the high duty on wool in 1867, both wool-manufacturing and wool-growing were very much depressed, owing to the fact that the public would not buy woolens at the enhanced prices. During this period it was very common for the commission-merchant to find that he had over-advanced to the manufacturer. The almost invariable result was a mortgage on the mill-property and a foreclosure. In this way A. T. Stewart acquired mill after mill, but even he failed to make his factories pay, and he is believed to have lost heavily by his woolen-mills. At his death his estate was burdened by a large number of these properties.—From the paper of Rowland Hazard, woolen manufacturer, before the Chicago Free-Trade Conference, November 12, 1885.

bill did provide; but he simply had a vague notion that he had an illegitimate advantage which somebody was trying to take away.

But, in addition to loss of this kind, the maintenance of the protection system has for a number of years resulted in a heavy surplus—a taxation of the people very far beyond the requirements of our Government. This surplus, therefore, must be charged up as one of the costs which the system entails upon the people. For the past seven years this annual absorption by the Government of the annual product has been very heavy. This present year, it seems, the House and Senate have by systematic extravagance succeeded in diminishing the surplus between fifteen and thirty millions. But it is admitted on all sides that the surplus fairly amounts to a sum not less than $125,000,000 annually. This is ten dollars per annum for every family in the United States. The total amount of the tariff taxation is about twice that sum. But if we view the family solely as consumers, and not at all as the recipients of protective bounty (which is practically a correct basis),* we have to add to this cost the enhanced prices of American products, some of which have been mentioned, and of which the Government gets no share. This indirect tax, of which examples have been given, is variously estimated in its total amount. On some articles it amounts to $13 when the tariff tax amounts to $1; that is to say, the consumer pays out $14 in enhanced prices, of which only $1 reaches the Government. On the whole, this indirect levy or transfer (it can not be called a tax) may be estimated to amount to about five times the tariff tax.† It amounts, therefore, to about $100 per family per annum, and, with the superfluous element of the tariff tax, to about $110. While this estimate is largely conjectural, no one who is aware of the increased expensiveness of our manufacturing, and even of our agricultural processes, will doubt that the figure is very large, and perhaps in excess of that named. This, be it remembered, is not a tax on property but a tax on consumption. The poor man pays as much on sugar and rice as the rich man. The carpenter with $2 per day pays nearly as much on clothing as Jay Gould, rated at $30,000 a day; and on no article of consumption or use are the rich and poor taxed in proportion to their wealth, because ninety-five per cent of the poor man's income is required to pay his family's living expenses, while the rich man uses a much smaller proportion for that purpose.‡

* In 1886 W. C. Ford, E. B. Elliot, and Simon Newcomb, statistical experts, reported to the Secretary of the Treasury their estimate of the number of persons in "protected" industries. Their estimates vary from 4·7 per cent to 5·2 per cent.

† I believe this is Mr. Wells's estimate.

‡ It is a frequently made reply to considerations like the above that, though protection

If the foregoing estimate is well founded, it is clear that very serious effects must be found both in the general state of the people and in that of various industries. Let us, therefore, make some general comparisons between this country and the greatest of those nations which have adopted a free-trade policy, and then survey as far as practicable the several effects of high tariffs on the laboring, farming, and manufacturing classes. Such a comparison must needs be more than fair to the United States, because they are growing rapidly in every respect, while England has more nearly reached a stationary state.

The total wealth and annual product of this country and England (applying that name to the United Kingdom of Great Britain and Ireland) are given as follows: *

	1870.		1880.	
	Total wealth.	Wealth per capita.	Total wealth.	Wealth per capita.
United States	$34,379,640,000	$899	$46.145,700,000	$923
England	33,436,680,000	1,065	42,379,200,000	1,210

	1870.		1880.	
	Annual product.	Product per capita.	Annual product.	Product per capita.
United States	$5,098,000,000	$129	$6,901,200,000	$132
England	4,613,000,000	146	5,549,000,000	171

Thus we see that the United States are not only behind England in wealth per capita, but in product per capita; and, still further, that the same relation existed in 1870, but not to the same degree as in 1880; England having made a greater gain during the decade. America gained $24 per capita in wealth during the decade, England $145; while the product per capita in America increased $3, and that in England increased $25.

In wealth per capita, Mr. Mulhall ranks the nations as follows: 1. England; 2. Holland; then France, Denmark, Australia, United States, Sweden, Canada, Belgium, Germany. In annual earnings per capita Australia is first; then England, the United States,

takes from some and gives to others, yet all are Americans—"it is all in the family." This proposition and the other great stand-by, that "foreigners pay the tariff-taxes," I find it difficult to answer seriously. When a philosopher starts out with an inconceivable proposition, it is rather difficult to argue. But we may say, in the first place, that justice has some place in the family as well as elsewhere. Moreover, much of what is taken from the people is, from an economic point of view, wasted: it is used up in sustaining extravagant and old-fashioned processes, unfavorable locations, and the like.

* See Mulhall's "History of Prices," which is generally accepted as a work of the highest authority.

Canada, Holland, France, Denmark, Belgium, Germany, Sweden, in the order named. Mr. Mulhall also computes that the average man in the United States works 113 days to gain his food for a year, as compared with 114 days' work in England; in England he works 34 days for his clothing, here he works 49; house-rent and taxes take 29 and 32 days in England, 30 and 33 days in the United States; and the Englishman consequently has 91 days in the 300 left for other purposes, including savings, whereas the American has but 75. The banking capital and deposits of England are $125 per inhabitant; of Australia, $150; of the United States, $50. The railroads of the United States carried 270,000,000 passengers in 1882, those of England carried 752,000,000; and the slight difference in railway rates is by no means an explanation of the difference. The school attendance in England has increased from forty per cent less per capita than ours in 1880 to about the same. The post-office returns show a greater increase in the use of the mails in England than here. And that faithful index of popular condition, the criminal calendar, shows a steady decrease for a long period, until, in 1885, there was but one conviction to 3,272 persons in England; while America has one conviction to 930 persons, which has been about the rate for a considerable time. And the statistics of pauperism, while not so favorable for England, show a steady and rapid decrease for fifty years, and the ratio of paupers to population is about one fourth what it was in 1840. It would be interesting, had we space, to show the greater consumption per capita of many articles in England than in America, as of woolen clothing, sugar, and rice, the total consumption of food products being about the same per capita; and to show the vast increase seen in England during the past forty years. Suffice it to say that the facts indicate a greater average of welfare in England than in this country. "There are few questions of fact upon which the general public are more misled by our public men than this," says Mr. Gunton, in his "Wealth and Progress"; "but the facts all point to the same result, viz., that the increase in wealth, in proportion to population, has been greater in England than in this country." Lastly, but most important of all to lovers of liberalism, legal equality, and popular government, England has, during the past twenty years, grown democratic "by leaps and bounds," and her vast wealth is certainly known to have been reaching a state of more equal distribution, while we have been erecting an aristocracy of wealth. The explanation of all this reduced to its simplest form is not difficult. England's citizens buy in enormous quantities and in the cheapest markets, and sell in enormous quantities in the dearest markets. The Englishman buys at $10, puts $1 worth of labor on the material, and sells at $15. We buy at $15, put $1 worth of labor on the material, and sell only to ourselves. The American is not naturally slow, but he can not run with the Englishman while his feet are fettered.

The protection system would obviously not stand for a year in this country were it not for the belief that it results in an increase of wages among our working-people. It is, therefore, especially important to observe the effects of protection upon our wage-earning class. First of all it is to be noted that great numbers of the working-people can not, in the nature of things, be any more subject to foreign competition under free trade than they are at present. This applies to railroad-men, now nearly 700,000 in number; men in the building trades, agricultural laborers, household servants, clerks, professional men, and the like. The numbers belonging to protected and non-protected industries stand about as five to ninety-five, as above noted. The vast discrepancy between the two is not usually taken into account in tariff discussions; but it is instructive, as tending to show that American labor is not in any danger of great displacement by any possible legislation or by any possible competition.

It is a startling fact, of which the application is not obvious, that, while the protected industries have produced more millionaires, perhaps, than any others, the wages paid to workmen in them reach a much lower level than the usual one in wages-paid occupations, and in some cases a most miserably low level. This circumstance is well known, and as such was stated by a number of iron-manufacturers who united in a letter to the late Secretary Manning, in reply to that of the Iron and Steel Association—for there are manufacturers of iron who do not believe that the tariff duty should be three or four times as high as the labor cost of the product: * "The figures of the census show that in the year 1879–1880 the total wages of $9,538,117 paid for mining ore, distributed among 31,668 men and boys, averaged but $301 per working year each, or less than a dollar for each working day. Since that time wages have been again and again reduced. It is a notorious fact that men are working in the mines for eighty cents a day or less." So true is this that, while the cost of living is much higher in this country than in England—for the reason that taxes are there not levied altogether on articles consumed in daily use—the wage-workers receive in many cases about the same in both countries. For example, Joseph D. Weeks, special agent for the tenth census, gives ("Statistics of Wages," pp. 112 and 119) a table of wages paid in the iron-making business in the Cleveland district in England, and in "an establishment in Pennsylvania":

* Letter of J. B. Sargeant and others to Hon. Daniel Manning, December 21, 1885.

EMPLOYMENT.	American.	English.
Keepers, per day	$1 47	$1 61
Keeper's helper, per day	1 35	81
Common laborer, per day	1 00	75
Carpenter, per day	1 23	1 05
Blacksmiths, per day	1 23 and 1 00	1 13

With this we compare American and English wages in non-protected occupations.* Mr. Wells gives from the last census the

EMPLOYMENT.	American.	English.
Carpenters, per week	$14 00	$9 45
Bricklayers, per week	20 00	9 45
Masons, per week	18 00	9 45
Locomotive-engineers, per week	27 00	7 30 to 12 15

average pay of the railroad employés of this country as $450 per annum; and that of the iron-workers as $312. The difference in the degree of skill required is not obvious, nor apparently sufficient to explain the great discrepancy. Lastly, we may cite the statistics brought together by Mr. Gunton in his "Wealth and Progress," and compiled from the concurrent data and results of Giffin, Mulhall, Levi, the United States census, and other great authorities. The comparison is made between several countries, none of whom have a tariff anything like as high as that of the United States. Mr. Gunton thus states the "rise in actual wages" in non-agricultural occupations, making the most favorable allowance to France and Germany, as follows:

	Wages per week.	Increase since 1850.	Hours of labor per week.
England	$7 44	$2 40	60
France	5 04	1 72	72
Germany	3 84	1 62	75
United States	——	(1 87)	About 66

These are very surprising facts, which merit careful attention. The very idea that American workingmen are not in every way in a better position than the English is so strange that we are naturally incredulous. The fact that we have such vast quantities of land, practically free, inviting the poorly paid to settle, would seem to be a sure defense of high wages, and doubtless is such. But there is an explanation, though it is probably but a partial one, in the effects of the tariff. The cost of living has been constantly rising in this country, while that in England has been fall-

* These figures are given for New York and London in the Government publication, "Labor in Foreign Countries," pp. 635 and 1663 to 1667.

ing. The census estimate of the increase in the cost of living in the United States during the thirty years ending in 1880 was 20·17 per cent, while during the same period the cost of articles of common use has fallen about twenty-four per cent. Obviously, the effect of this would be to put the English wage-worker in a constantly better position to demand better wages; while the American, with his cost of living tending more and more to consume his whole income, is in a constantly worse position to demand an increase. It need not be remarked how potent a factor this is, nor need the responsibility of the high tariff for the high prices prevailing be carefully demonstrated. There is not a thing eaten or a cloth worn which does not pay a tariff tax. The wheat is sown after a plow taxed twenty-five per cent in actual extra cost; and is transported on railroads, ground up in mills, put in bags, and sold in stores, all heavily taxed in their construction and maintenance by the tariff on iron. And on many articles, such as clothing, the amount of the tax is scandalously oppressive.

This may or may not explain the failure of American wages to rise to the same extent as English in the non-protected occupations, and, at any rate, there are other causes acting, such as the waste of capital caused by the war, and the heavy immigration of wage-workers. But we need a special explanation for the singular fact that wages in the protected occupations continually fall, even while the general trend is upward. In General Lieb's recent book on the tariff he has a comparative table of wages in twelve unprotected and in twelve protected occupations. In the first, wages rose in the six years following 1880 from ten to thirty-five per cent, while wages in the protected occupations fell from five to thirty-five per cent at the same time. These facts are well authenticated and even "notorious," as remarked in the letter before mentioned to Secretary Manning; but we seldom if ever are shown the reason. I think this can be directly traced to the high tariff. Take, for example, the iron-manufacturing business. In general the American prices are much below the foreign price plus the duty, and importation is impracticable. When the operators have this margin to work on they frequently accumulate a considerable supply beyond the immediate demands of the market. Then, asserting that the market is dull, they reduce wages. The men strike, of course, and the mills close. As production ceases, the price of iron goes up; and, as the foreign iron can not come in, the masters are fairly coining money out of the necessities of the public and the suffering of their own employés. In the course of a few months the latter accept the situation and go back to work at reduced wages. If foreign iron could come in the moment production ceased in this country, the masters would not be so quick to shut down as they are when they make money out of it; the laborers would be on an equal footing with the masters. But, as it is, the masters have both the public and their employés "in chancery," and have so far been able to resist the otherwise universal tendency to advance in wages. The little circle of events which I have outlined has taken place again and again in Pennsylvania, as the frequent strikes (more frequent, I believe, than anywhere else in the Union) in part testify. These circumstances can not long escape the attention of the leaders of the laboring-people, and from the rising unpopularity of protection among them we may confidently predict that they will not much longer be deceived.*

The depression of American agriculture is well known. In the ten years 1850–'60 the value of American farms more than doubled. In the following twenty years the value increased slightly over 50 per cent. So far as the influence of the tariff is felt in the value of farms, it might be supposed that its operation would be very favorable in the manufacturing States. Yet even here the percentage of increase in value for the decade 1850–'60 is greater than for the twenty years following 1860. All the New England States, save Massachusetts and Rhode Island, show a nominal decrease in the decade 1870–'80, and, even allowing for the 25-per-cent depreciation of greenbacks in 1870, the increase is not great; it does not by any means keep pace with the decade of 1850–'60, during which there was a low tariff. The State of Illinois should be a fair example of what has happened in purely agricultural States. From 1850 to 1860 the increase was 412 per cent; from 1860 to 1880 it was but 250 per cent. The census does not show the mortgages on farms; but, according to the statistics printed in the "New York Times," ten agricultural States have their farms mortgaged for $3,422,000,000 on a total valuation of less than four times as much. It would be surprising if agriculture were not depressed. The same state of affairs exists in American farming as existed in 1840 in English manufacturing, when Cobden and his friends associated themselves to bring in free wheat and to break the power of the landlords. Every tool which farmers use, and nearly every article they consume, bears a heavy tax, just as in Great Britain the high-tariff prices of provisions made it impossible for the manufacturers to pay subsistence wages to workmen. This country naturally manufactures agricultural machinery, and would do so even under absolute free trade, as is proved by the fact that we export it, but the duty on iron-ore and pig-iron makes the price from 15 to 25 per cent higher. Sugar is enhanced in price about 75 per cent by the tariff, and clothing, furniture, and lumber are largely raised in price to

* This explanation was first made, I think, by Mr. Benjamin Reece, at the Free-Trade Conference of 1885.

the farmer. In return, he gets the "home market"; but, inasmuch as he gets precisely the same for his grain, whether it is sent to Liverpool or to Pittsburg for consumption, this does not seem quite compensatory.

As might be expected, the manufacturing interests make a better showing than the agricultural. Yet even in this favored branch of business the percentage of increase in 1850 and 1860 is greater than that between 1860 and 1880; if the rate shown in the former period had been maintained, the manufactured products for 1880 would have been greater in value than it is shown to be by the census by about a billion dollars. It will be observed that these figures are based upon the products of the census years 1860 and 1880, and, as the year of 1860 was one of great depression and that of 1880 of great prosperity, the facts are more strongly in favor of the low-tariff period than is indicated on the face of the figures. Thus, though the manufacturing interest is supposed to be the particular beneficiary of protection, it, too, shoulders some of the burdens of the tariff; and the New York "Evening Post" publishes a list of two hundred manufacturers who favor a reduction. Some industries, such as ship-building, have been nearly destroyed by the high tariff on everything which goes into a ship, and while in 1860 there were twenty ship-yards about New York, there is hardly one left. So with many manufacturers of hardware, which is made altogether too expensive to be readily marketable, by reason of the high cost of the material of which it is made.* And countless derangements and dislocations of industry might be instanced as manifestly due to the tariff. The loss of the carrying-trade has perhaps been sufficiently dwelt upon, but it is still somewhat startling to be brought face to face with the fact that, while in 1860 our ocean marine equaled England's, it at present is about seven per cent of that great country's, and is yearly decreasing. It is calculated that nearly four billion dollars have been paid out on American ocean freights since the war, of which the Americans have got very little. Not only have we lost the carrying-trade, which was rapidly falling into our

* In the "New York Times" of July 18, 1888, Mr. Frank Wilkeson makes a remarkable showing of the effect of the tariff on iron- and steel-making. He computes that pig-iron ought to be produced in Alabama and on the southern shore of Lake Erie at $7 per ton cheaper than anywhere else in the world, and with no reduction of wages whatever. (Moreover, he takes no account of natural gas.) He claims that iron is now made in Ohio and Alabama for little more than that amount, and that the duty of $7 per ton has simply enabled furnaces to stay in Pennsylvania, where every element of cost is very great except the cost of labor, and that the manufacture of iron is thus unnaturally expensive and profitless to everybody. Pig-iron has within eight years sold for $40 per ton, and manufacturers claim that it costs them $15. Mr. Wilkeson says, "The iron-works which will inevitably be built on the shores of Lake Erie will bankrupt every blast-furnace and rolling-mill in Europe." But not so long as a high tariff and combinations protect every manner of extravagance.

hands, but we have thus lost opportunities of export. If an American locomotive is shipped, as many have been, to the Argentine Republic in competition with English engines, it has to be sent in English boats *via* Liverpool, our people standing the disadvantage of the additional charges, time of transport, and interest. Under these circumstances we lose all trade except that gained by great superiority, as in the case of locomotives. Thus the very duty intended to benefit the iron industry reacts. It secures the home market for the manufacturer, but destroys the foreign market, and in times of inactivity, or when the market is glutted by overproduction, there is no opportunity for relief by recourse to a foreign customer. Again, if our manufacturers wanted a machine not to be obtained in America, or raw materials to be had here only at great expense, the Government taxes them at a fearful rate. I am credibly informed that it is for this reason that Mecham & Co., glass-manufacturers of Pittsburg, have resolved to locate in Belgium, where they can get their materials and machines free. So with the Rochester tumbler-works, which, I am also informed, are about to leave an illiberal country. It is thus that we may see one reason for the existence of the great American business colony in Europe. This country pays a premium to many industries to get out of it. Obviously, too, our railway lines lose heavily by the diminished volume of exchanges, just as they would if State or country tariffs were set up. They pay thirty per cent extra for their supplies, and, by way of compensation, are deprived of part of their natural trade. Turn where we will, we find derangements, if not actual loss. Placing, as protection does, everything upon an unnatural footing, liable at any moment to give way, it would be irrational to expect sound and healthy industrial growth. The hysterical fear of some of the protectionists, that English competition and "pauper labor" will "crush" American industry, is rather ludicrous, in view of the history of the American and English competition. If there has been any instance where English competition has not been successfully met in America I do not know it. Indeed, Cobden himself recognized that the United States were the great and only menace to English commercial supremacy. Not to mention others, Mr. Gladstone is quoted as saying, in a public speech: "I will say this, that as long as America adheres to the protective system your commercial primacy is secure. Nothing in the world can wrest it from you while America continues to fetter her own strong hands and arms, and with those fettered arms is content to compete with you, who are free, in neutral markets."

That protection has any effect in fostering "trusts" has been vehemently denied, but so have many other obvious propositions. Protection lessens the number of possible competitors, and consequently makes combination easier. It might be practicable to get up a combination to control production and prices in the United States, and yet be impracticable to form one to cover the entire world. Of the enormous sums beyond a reasonable profit which these concerns have taken from the people we have no accurate knowledge, but the amount even in single cases, such as the sugar trust, is simply vast. It is not argued here that these combinations are criminal. But will it, on the other hand, be argued that we are bound to "protect" them? Are they to combine to force high prices from the people, and are the people to meekly assist in the process?

The central idea of the protective system is to compel our people to buy at home, while allowing them to sell abroad—thus retaining our money at home and adding to it. This is the old mercantile theory so popular during the middle ages. It needs but little reflection to see that such a programme can not be indefinitely carried on. If hundreds of millions of gold are brought into this country, gold becomes cheap, while abroad it becomes dear. There soon comes a time, therefore, when the gold will seek purchases abroad in consequence of its high value there. If we "corraled" all the gold in the world, the only thing we could do with it would be to send it abroad and buy with it. This process has already begun; for, during the year 1887, and much more the year ending June 30, 1888, the balance of international trade was against us. Some protection organs, failing to see the meaning of this, called for still higher tariffs. But that gold is only valuable as it enables our people to buy with it would seem to be axiomatic, however much it is forgotten.

It might be inferred from the above, as it is certainly demonstrated by experience and well understood by economists, that in the long run imports and exports must balance each other, except where, as in the case of England, imports are made to balance incomes derived from foreign investments. But if this be true, then a tariff on imports is also a restriction on exports. Have we found this to be true? Not to rely on such general principles as that all international trade is essentially barter—an exchange of product for product—because payment in gold instead of bills of exchange is too expensive; because freights without return freights are too high; and because, as experience everywhere shows, people learn to buy wherever they sell; not to rely on abstract propositions, let us appeal to the statistics of American and English exports and imports:

	Exports.—Average, 1861-1880.	Imports.—Average, 1861-1880.
Great Britain	£245,000,000	£321,000,000
United States	74,000,000	74,000,000

Passing by such important facts as that we have almost entirely lost our South American trade; that Europe shows an increasing tendency to buy her grain elsewhere than here—I appeal to the following interesting fact cited in one of Mr. Hurd's speeches: In 1870, before sugar was admitted free from the Hawaiian Islands, our exports to them amounted to $590,000; and in 1883, after the sugar kings had been favored, our exports were $3,683,460. In a few years our exports increased sixfold; and Americans now control both the business and the politics of the islands. There is no reason why something like the same proportion should not hold for other countries, especially for Australia, South America, Canada (whose trade has been most senselessly sacrificed), and even for England. But supposing that our whole trade would have increased in only half the above proportion, we find that our exports might have been, in 1887, $2,250,000,000 instead of $750,000,000. Had this been the case, our imports would similarly have increased, and our people would have bought and sold to an advantage of at least a billion dollars more than they have, and would have been at least a billion dollars better off.

Heretofore we have taken a survey, necessarily rapid and incomplete, of the strictly industrial effects of the tariff. Let us now pass to a consideration of its general social and moral effects. We shall find their mere enumeration a serious task. The tendency to undervaluing of imports is well known, and is inevitably inherent in the tariff system; and on this account alone the tariff has been said to make us "a nation of liars." Newspapers are subsidized by its beneficiaries, and false information is systematically spread and groundless fears aroused among the ignorant. Money is sent to districts of tariff reformers to defeat them. Each protected industry maintains a watchful lobby at Washington in its interest. Sham conventions are got up to affect public opinion. In short, it is the old story of privilege maintaining itself by all means fair and foul. Just as Bright and Cobden were denounced as red-handed revolutionists for advocating untaxed bread for the people, so the mildest revenue reformer is now "in favor," in the words of General Alger, of Michigan (who owns several millions' worth of protected pine), "of moving American industries to England." Mr. Cleveland, according to other profound statesmen, "desires to ruin American workingmen." Ludicrous as such talk is, it has its serious side in the debasement of politics and the destruction of intelligent discussion. It is not indeed to be expected that the political discussion of any subject will be remarkable for research or breadth of view. Still, one must be surprised at the manner in which the protection side has been defended by its chief supporters. Mr. William McKinley, Jr., is supposed to be the ablest and most intellectual of the champions of a high tariff, and his speech on the Mills bill, which was carefully revised, contains some interesting examples of the political and intellectual effects of protection. In one place (p. 32) he asserts that "the working-people of England find that competition with countries employing cheaper labor is too oppressive to bear longer, and are demanding to be saved from further degradation," etc. This, in the face of the marvelous and universally admitted increase in wages and comfort of English labor already mentioned, and also in the face of the conspicuous fact that not a single prominent politician in England champions protection, and that the only protectionists are landlords whose rents are being reduced. In the same speech (p. 27) he attacked the Administration because it bought two thousand blankets for the army of an English firm, when, by paying $606 more, it might have patronized an American firm. Mr. McKinley's theory was that this money should not be saved to the tax-payers, but should be paid, as a bounty, to the American firm. On page 18 he said, "I would not allow a single ton of steel to come into the United States if our own labor could make it." If this is economic wisdom, why should not each State, each county, take the same policy? Mr. McKinley offers no explanation, save that we have "one flag"; but leaves to the imagination what the flag has to do with industrial success. But the *ne plus ultra* doctrine is on page 13: "I would rather have my political economy founded on the every-day experience of the peddler than the professor." In other words, the more we study the subject the less we know about it. Science is a delusion and snare for the impracticable. Ignorance alone is learned. We should not expect to hear from Mr. McKinley that industrial growth, like all organic growth, should be in the line of least resistance and greatest traction, which is the opinion of a sociologist; but we are hardly prepared for his assumption that labor cost is identical with the rate of daily wages. I instance Mr. McKinley's speech, because it is a type. On looking through the other leading speeches against the Mills bill we find the same neglect of facts, the same contempt for science, violence of assertion, disregard of business principles, and coarseness of reasoning. Nowhere do we find any account taken of the history of trade, the prosperity of trading nations, or even the elementary fact that English labor successfully competes with Indian and Chinese labor five times as poorly paid. Indeed, their theory would make this impossible, and therefore it can not be true.

Another very serious indirect effect of the high tariff is that the surplus revenue obtained breeds profligate schemes without number. It seems to be forgotten that the Government of the United States was carried on during J. Q. Adams's administration —one of the best this country has seen—for about $10,000,000 a year. While our population has only increased five times since then, and our area doubled in extent, the Government spends twenty-five times as much. Extravagance has permeated every department of Government. Perhaps $150,000,000 is wasted in this way every year. Aside from this, however, we have to notice a few of the ridiculous schemes which have been advanced to dispose of the surplus. The worst is probably the proposal to use it to bring up the price of silver, advanced in a congressional speech against the Mills bill.* This was devotion to "labor" with a vengeance. Then it is proposed to use it in educating the South, in defiance of the Constitution and of every healthful dictate of expediency. Another proposition, likewise well supported in Congress, has been to dig the Hennepin Canal, which can not be soberly regarded as anything more than a local enterprise of so poor a commercial character that no private company would think of going into it. And in the improvement of harbors, the supporters of protection have encouraged the waste of enough money seriously to diminish the surplus.† Governor Foraker proposes that the Government buy land and put up public buildings in every town of three thousand inhabitants and over. Then there are innumerable people who want bounties and subsidies for their enterprises. Not to speak of the extravagance and heedlessness of our present pension legislation, we are dangerously near the institution of civil pensions. Lastly, there are schemes to spend any imaginable surplus in fortifications against imaginary enemies and on a navy, which, amounting to nothing with $400,000,000 put upon it since the war, might possibly amount to something if twice that amount were expended. The surplus has also attracted the attention of one of the Labor parties, which thinks the Government ought to "loan" it to "the people." Other protection countries have had the same experience. Canada has been given over to profligate government ever since she adopted a protection policy. Where the Government goes on the theory that the more money taken from the people the better for everybody, it will not be very careful of its expenditures.

One further serious effect to be apprehended, if the protection idea obtains sway, must be mentioned. This is a demand for State and local protection. No logic that makes it advantageous for Kansas to protect herself against England can long resist the conclusion that it would also be well to protect her against Pennsylvania. This idea would the more readily spread because it is obvious that the tariff is a tax on the Western States for the benefit of the Eastern, it being as certain as anything can well be that

* By Congressman Cheadle.

† One harbor within my knowledge has had more spent upon it by the Government than the entire town is worth.

tariff taxes cost Kansas $100 where they bring her $1. Various efforts made by Tennessee and other States to fetter interstate exchange by taxation of drummers, etc., have already been made, but have happily been nullified by the Supreme Court of the United States. Nevertheless, if the idea becomes implanted that this is the best policy, the true way to get rich, the will of the people will in the end prevail. The legitimate and logical outcome of protection is a dissolution of the Union, and the establishment of fifty tariffs instead of one. Although I do not believe that any such thing will happen, it is worth while to point it out to those who, like Mr. McKinley, are logical and thorough-going protectionists, and believe in the speedy and permanent triumph of their idea.

But this is not the American idea. It is not the idea of the Declaration of Independence or of the Constitution. Our fathers did not intend that Congress should have the power to create an industrial aristocracy, that certain classes should be saddled on the rest, and that American citizens should be deprived of the manifest and inalienable right to exchange the fruits of their labor wherever they saw fit. A more liberal spirit pervades that document, and in an important case the Supreme Court, through Justice Miller, has used language clearly implying that protection *per se* is unconstitutional.*

Speaking of the lessons that the last twenty years of its activity had given to the Church, the Bishop of Lichfield said, in the opening address of the last English Church Congress: "Twenty years ago we discussed in our Congress the relations of the Bible and science. The discussion has gone on unceasingly, and is likely to continue for a long time to come. But its character and conditions are changing. The time of loud assertion and angry controversy is passing. Timid minds are still staggered by the discoveries of science, but they are beginning to remember that all truth is of God. The honest doubter is no longer regarded as a criminal, but as an invalid. It is even admitted that there may be a considerable religious element in doubt."

* Judge Story (sections 1077–1097 of his book on the Constitution) has lent the weight of his name to the opposite view. But Judge Cooley says ("Principles of Constitutional Law"): "Constitutionally, a tax can have no other basis than the raising of revenue for public purposes, and whatever has not this basis is tyrannical and unlawful. A tax on imports, therefore, the purpose of which is not to raise revenue, but to discourage and indirectly prohibit some particular import for the sake of some manufacturer, may well be questioned as merely colorable, and therefore not warranted by constitutional principles." And in Citizens' Savings-Bank *vs.* Topeka, 20 Wall, 635, the court said: "There are limitations" on all American legislatures "which rise out of the essential nature of all free government. Among these is the limitation of taxation that it can only be used in the aid of a public object. It can not, therefore, be exercised in the aid of enterprises strictly private for the benefit of individuals, though in a remote or collateral way the public may be benefited thereby." It was decided in this case that it was illegal to tax Topeka to pay manufacturers to locate there.

PALEOLITHIC MAN IN AMERICA: HIS ANTIQUITY AND ENVIRONMENT.

By W J McGEE,
OF THE U. S. GEOLOGICAL SURVEY.

I.

DURING the unlettered youth of the race there were no written records from which the antiquity of man can be read. So the anthropologist on the one hand, and the geologist on the other, have sought to construct an early human history from prehistoric relics, and from the formations in which they are imbedded or the fossils with which they are associated. Lubbock divided prehistoric time into four great epochs, viz.: 1. The Paleolithic or rough stone epoch, during which primitive man flourished; 2. The Neolithic or polished stone epoch, during which higher development was reached; 3. The Bronze age; and 4. The Iron age.* These divisions, at first supposed to represent successive eras, are now regarded as representing cultural phases rather than periods of time (in fact, all are found among the present population of the world), and they are accordingly valueless as measures of the antiquity of man upon the globe. The geologist classifies later geologic time as Cenozoic or the era of modern life, divides it into Tertiary and Quaternary (or Pleistocene), and subdivides the Tertiary into Eocene, Miocene, and Pliocene. But no part of the geologic record, as hitherto interpreted, is more indefinite than that of the transition from Tertiary to Quaternary, or from Pliocene to Pleistocene; and this indefiniteness is especially unfortunate for American anthropology, since it was about this period that the autochthon—the primeval inhabitant of the continent—first appeared. It is, indeed, customary to recognize the geologically recent glacial period, during which northern United States was overspread by an ice-sheet extending southward to the thirty-eighth parallel, as the initial episode of the Quaternary; but it is becoming apparent that this period is too long and too vaguely defined to satisfy inquirers for a date of man's origin.

Recent researches in the Great Basin of western America, in the Mississippi Valley, and in the Atlantic slope, have shown (1) that the glacial period consisted of two epochs of humid climate and glaciation (the later comprising two or more sub-epochs); (2) that these cold and wet epochs were preceded, separated, and followed by climatal conditions much like those of to-day; (3) that the intervening a-glacial epoch was of considerable dura-

* "Prehistoric Times," American edition, 1875, pp. 2, 3.

tion; and (4) that the earlier epoch of cold was the longer, though the cold was the more intense and the climate more variable during the later epoch.

The latest researches in the Atlantic slope have shown more definitively (1) that the interval of mild climate separating the two cold epochs was from five to ten times as long as the post-glacial interval; (2) that the cold epochs themselves were brief in comparison with the inter-glacial and post-glacial intervals; and (3) that the earlier and longer epoch of cold was attended by continental submergence reaching four or five hundred feet in the latitude of New York and extending to South Carolina, while the land depression of the later refrigeration was but forty or fifty feet at New York, and scarcely extended beyond the great terminal moraine of Long Island and northern New Jersey.*

During the first epoch of cold and wet local glaciers formed in the Rocky Mountains and in the Sierras, the Great Basin (which these ranges bound) was flooded and the now extinct Lakes Bonneville and Lahontan were formed, and into the lakes great volumes of sand and silt—the lower lacustral beds of Gilbert and Russell—were swept by the flooded rivers; at the same time the northern ice-sheet stretched down into the Mississippi Valley as far as the Missouri River, the land was depressed, and both glacial and aqueo-glacial deposits were laid down; and it was at the same time, too, that the Atlantic coast was depressed until the high hills overlooking New York, Philadelphia and Washington were half submerged, and that the rivers built great deltas of gravel and loam along the shore of the expanded ocean, while the waves dropped shallow-water sediments all over the lowlands. With the interglacial warmth the glaciers of the Western mountains were melted, the lakes were dried, and river-gravels were deposited by the shrunken streams over and cañons were cut into the old lake-bottoms; in the Mississippi Valley the glaciers retreated and the drift-plains became forest-covered; while in the East the land underwent re-elevation, and there was erosion of such extent as to afford a rough measure of the duration of the warm interval. During the later epoch of cold and wet glaciers again formed in the Rocky Mountains and in the Sierras, Lakes Bonneville and Lahontan were refilled—the former to overflowing—and the upper lacustral beds were laid down within them; the northern ice again invaded the Mississippi Valley and formed two or more drift-sheets, together with the peculiar glacial-mud deposit (or loess) into which they graduate, as well as the great terminal moraine stretching from Ohio to Dakota; and in the East the ice again overrode the Adirondacks and the New Eng-

* "American Journal of Science" for May and June, 1888; "Seventh Annual Report of the United States Geological Survey," 1888, p. 537 *et seq.*

land ranges, crept southward to Long Island and northern New Jersey, and heaped up the eastern extension of the terminal moraine, and, as it melted, gave origin to the Champlain deposits of the New England rivers and to certain distinctive aqueo-glacial gravels, of which those of the Delaware at Trenton are the type.

The lower lacustral deposits of the Great Basin, the aqueo-glacial deposits of the Mississippi Valley, and the ancient deltas of the Atlantic slope are correlated, partly because (1) each attests a great and similar climatal episode, because (2) it is evident that each of these episodes was so extreme as to affect the entire breadth of the continent, and because (3) there are no indications among American geologic deposits of other episodes with which these might be confused; the upper lacustral beds of the Great Basin, the upper glacial and aqueo-glacial deposits of the Mississippi Valley, and the glacial deposits of the Atlantic slope, are correlated upon similar grounds; and the harmony among the various records gives cumulative proof of the accuracy of each.

By these researches of the last decade the earlier conceptions of Quaternary history are greatly expanded, and the hitherto obscure relation between the Tertiary and Quaternary is made clear. Where they contain vertebrate fossils, the earlier and even the later of these deposits are, it is true, referred to the Pliocene by paleontologists, while physical geologists refer the entire series to the Quaternary; but this discrepance is one of classification only, and in no way affects the phenomena classified.

The sequence of events made out independently in the three widely separated regions may be depicted as in the accompanying diagram (Fig. 1), representing the temperatures and land-altitudes

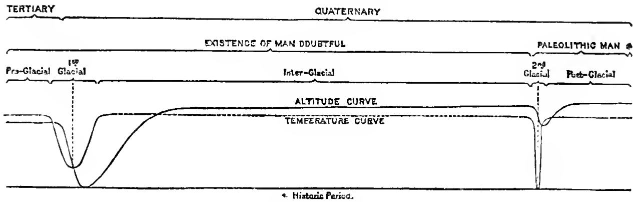


FIG. 1.—GRAPHIC REPRESENTATION OF CLIMATE AND CHANGES IN ALTITUDE OF THE LAND.

during late Tertiary and Quaternary time. By such a chronograph alone is it possible to accurately measure the antiquity of paleolithic man. Marsh has well shown that only long æons can be measured by plant fossils, that somewhat shorter periods may be measured by the records of invertebrate life, and that the vertebrates afford by far the most delicate of the paleontologic time-measures; but the swing of even the vertebrate life-pendulum is long as compared with that marking the transitory stages of human development, and must give place to the still more precise chronometer afforded by the brief and sharply defined climatal episodes of later geologic time; the human records of diverse regions can only be correlated in terms of these brief episodes; and in ascertaining the relations of paleolithic man to the two best known climatal episodes of the past, it is immaterial whether these be called Tertiary or Quaternary. It is the special merit of the graphic method that it exhibits quantitative relations (for while verbal language is commonly qualitative, graphic language is always quantitative); and in the present case it affords a means of measuring the consistency of the evidence, and of instantly detecting the inconsistent records, of human antiquity.

There are several well-authenticated discoveries of human relics in this country in geologic deposits whose places may be fixed in the graphic time-record forming Fig. 1. Aughey records two chipped implements from the loess of the Missouri Valley, one of them coming from immediately beneath an elephantine vertebra; Miss Babbitt has found great numbers of quartz-chips in a Champlain terrace of the Mississippi at Little Falls, Minnesota, which are regarded by many archæologists as unquestionably artificial; N. H. Winchell records polished stone and copper implements as well as human bones from the same aqueo-glacial terrace of the Mississippi near Minneapolis; Belt several years ago found a fossilized human skull in what appears to be the westernmost extension of the loess in Colorado; Gilbert has shown that the geologic position of an ancient hearth found in excavating a well in northern New York indicates that it was constructed during the closing episodes of the last glacial epoch; a few years since McGee discovered a chipped obsidian implement imbedded in the upper lacustral marls of western Nevada; McAdams notes the finding of a stone axe in loess seventy feet beneath the surface in Illinois; and among the most recent and satisfactory archæologic discoveries of this country are those of two chipped implements of black flint found in Ohio by Dr. C. G. Metz, at Madisonville and Lovelands respectively, in deposits of loess and aqueo-glacial gravel which G. F. Wright has shown to represent a closing episode of the later glacial epoch. But it is in the aqueo-glacial gravels of the Delaware River at Trenton, which were laid down contemporaneously with the terminal moraine one hundred miles farther northward, and which have been so thoroughly studied by Abbott, that the most conclusive proof of the existence of glacial man is found; and it is here, too, that the most satisfactory evidence is obtained concerning the conditions by which paleolithic man was surrounded. It is significant that in all these cases the human relics were found in deposits representing the closing episodes of the later epoch of Quaternary cold.

There are several cases in which traces of human activity have been reported from older deposits, but in which the discoveries are not so well authenticated. E. g., there is Dr. Koch's well-known record of the finding of mastodon remains in the Osage Valley, Missouri, associated with human implements and traces of fire, in deposits probably contemporaneous with those of the earlier ice-sheet; but the geologic relations have never been clearly made out, and the verity of the discovery has always been (perhaps unjustly) questioned. The finding of a fossilized human bone at Natchez, Mississippi, apparently associated with an early Quaternary fauna, is equally well known; but the attendant circumstances were not such as to carry conviction to the minds of contemporary students. Lewis, also, has described a paleolithic implement from aqueo-glacial gravels at Philadelphia; but he did not personally witness the discovery, and was not certain that the object came from the older (earliest glacial) and not the newer (latest glacial) gravels. It is significant that in all these cases the testimony is internally defective; and, since its acceptance would many times multiply human antiquity as established by collateral evidence (as clearly shown in Fig. 1), it would seem especially wise to reserve judgment upon it.

There are other cases in which human remains have been found in such position as to indicate great antiquity measured in years—e. g., the shell-heaps of Damariscotta River in Maine and St. John's River in Florida, representing a fauna now extinct or displaced; the enormous shell-heap at San Pablo on the Bay of San Francisco, which evidently represents a vast period of building; the shell-beds and superimposed deposits of the Aleutian Islands, which have been shown by Dall to represent at least three thousand years of accumulation, etc.; but in none of these cases is it possible to reduce the historic time-units to definite geologic time-units.

There are still other cases in which human relics have been reported from deposits of considerable geologic age—e. g., in Calaveras County, California, near Golden, Colorado, etc.; but, while the archæologic evidence would seem conclusive in at least one of these instances, it is impossible to confidently transmute the paleontologic record of the age of the deposits into the physical record which alone is sufficiently refined for the measure of human development; and it would thus seem wise to reserve judgment in these cases, also, with respect to the correlation of the deposits as well as to the association of the relics.

Excluding all doubtful cases, there remains a fairly consistent body of testimony indicating the existence of a widely distributed human population upon the North American Continent during the later ice epoch. The records are not equally decisive, it is true; the artificial character of Miss Babbitt's quartz-chips has been questioned, and they represent a stage of culture widely different from that represented by Winchell's objects from the same deposit; it has been suggested that McAdams's axe may have been an adventitious inclusion; Belt's untimely death prevented final statement of the geologic position of the Colorado skull; the apparently conclusive structural evidence of the antiquity of the Nevada obsidian is opposed by its fresh aspect and modern form; and Gilbert's hearth was not seen by the geologist who studied its relations. Yet, however the doubtful cases may be weighted, the testimony is cumulative, parts of it are unimpeachable, and the proof of the existence of glacial man seems conclusive. But the evidence of man's existence during the earlier epoch of glacial cold is not conclusive; and the evidence of still earlier human occupancy of the continent is not reducible to the terms of definite geologic chronology. Moreover, there is a body of negative evidence which is worthy of consideration. The lower lacustral deposits of the Great Basin have been as carefully explored as the upper, but have yielded no trace of human remains; the oldest glacial and aqueo-glacial deposits of the Mississippi Valley have been explored in Nebraska, Illinois, Missouri, and Ohio, as carefully as the later deposits, but (if Dr. Koch's famous find be excluded) no traces of human occupancy have been found; and, most significant of all, the deposits of the earlier cold epoch throughout the District of Columbia have been scanned for years by a dozen trained collectors and not a single object of human manufacture has been found within them, though thousands have been found on the surface, and though it might be shown that the conditions for savage life were as favorable on the Potomac during this epoch as they were on the Delaware during the later.

The various archæologic discoveries of America display striking diversity in the degree of development exhibited in the relics, which range from the rudest "turtle-backs" to finely chipped flint, polished stone, and even copper; but whether this disparity indicates adventitious inclusion in certain cases—and thus weakens the chain of evidence of human antiquity—or heterogeneity in the primitive population, can not yet be decided. Whatever interpretation be placed upon the questionable cases, however, there is convincing proof not only of man's existence, but of the definite stage of culture called paleolithic, in the later cold epoch of the glacial period. It is indeed obvious that the autochthon must have found birth anterior to this epoch, but the objective evidence of pre-paleolithic art has not been ascertained; and, since the date of origin of a higher culture is unknown, it can only be said that the

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paleolithic stage began toward the close of the later cold epoch and extended well toward the historic period, probably overlapping far upon the neolithic stage. Thus the place of paleolithic man in the chronograph afforded by geology is that shown in Fig. 1.

It should be pointed out that the human period of America can not be synchronized with that of Europe, since the geologic chronometer employed abroad is not sufficiently sensitive. It is true that Penck * and others have recently read from the glacial and associated deposits of the Alps a climatal record coinciding exactly with that recognized in this country † (save that the duration of the episodes is less closely measured), and that Mortillet ‡ and others have inferred a definite climatal sequence from the

Conspectus of Quaternary History.

United States.			The German Alps.		Northern France.	
			Post-glacial period.	Erosion of valleys; filling up of glacial lakes.		
Second cold epoch.	Cold climate.	Formation of Lake Agassiz clays and Champlain deposits. Terminal moraines and third drift-sheet.	Last glacial period.	Erosion in the central part, moraine building at the periphery, and sedimentation by ice-fed streams without the glaciated districts.	Magdalénien.	Cold and dry. Formation of red alluvium; atmospheric deposits.
	Mild climate.	Relatively short a-glacial interval. Erosion of river-valleys.	Last inter-glacial period.	Erosion of valleys; filling up of glacial lakes; formation of Innsbruck coal, etc.	Solutréen.	Milder temperature; very short relatively. Continuation of terrace formation; retreat of glaciers
	Cold and wet.	Loess passing into second drift-sheet in central U. S. Upper lake-beds in the Great Basin. Moraine-bordered drift in eastern U. S.	Middle (second) glacial period.	Moraine-building; sedimentation by glacial streams.	Moustérien.	Cold and wet. Formation of terraces, great extension of glaciers, clearing out of valleys, and accumulat'n of soil.
Interglacial period.	Mild climate.	Long a-glacial interval. Formation of medial gravels in Great Basin and forest bed in Mississippi Valley. Erosion in eastern U. S.	First inter-glacial period.	Erosion of valleys; filling up of glacial lakes; formation of old deltas and breccias, river alluvium, and lignites with associated deposits.	Chelléen.	Warm and wet. Superior loam, high level alluvium, filling up of valleys, and removal of soil.
First cold epoch.	Cold and wet.	Lower lake-beds in Great B'sin, "Gumbo" passing into first drift-sheet in Mississippi Valley, Columbia formation in eastern U.S.	First glacial period.	Erosion and deposition by ice and glacial streams.	(Not represented.)	

* "Die Vergletscherung der deutschen Alpen," 1882, Tabelle II.

† "American Journal of Science," third series, xxxv, 1888, pp. 462–466.

‡ "La Préhistorique Antiquité de l'Homme," 1885, p. 131.

relic-bearing deposits of central France; but, as shown in the accompanying table, the records are not accordant in their entirety, and can only be reduced to common terms by juxtaposing the earliest recognized Quaternary episode of the lowlands with one of the episodes of the later Quaternary in the mountains. This allocation harmonizes the evidence as to the antiquity of man on opposite sides of the Atlantic, but runs counter to current opinion and appears inconsistent with certain cavern phenomena, and can therefore be set forth as only a possible one. In this as in other cases, paleontologic correlation is incompetent if not utterly meaningless, since the episodes dealt with were so brief that chorologic diversity among the higher animals was unquestionably more important than chronologic variation—indeed, the latest lacustral (and relic-bearing) deposits of the Great Basin, which are referred to the Pliocene upon paleontologic grounds,* appear to have an older facies than the oldest relic-bearing river-deposits of France.

II.

The chipped implements found by Aughey appear to have been dropped on the bottom of the shallow lake or muddy swamp within which the loess was accumulated; since the loess itself consists of glacial mud, and since the basin in which it was deposited was bounded on the north by the Quaternary *mer de glace*, the climate must have been cold; and the associated elephantine remains prove the association of man and mammoth. The relics themselves throw little light upon the habits of their makers, but suggest that they were well advanced in the fabrication of chipped implements. If the obsidian implement from the Nevada lake-beds was really *in situ* (as all appearances indicated), it must have been dropped in a shallow and quiet bay of the saline and alkaline lake Lahontan, and gradually buried beneath its fine mechanical sediments and chemical precipitates; as indicated by the associated fossil bones and teeth, its makers must have been contemporary with the indigenous horse, an elk or deer, an elephant or mastodon, the camel, a gigantic ox, and other extinct animals commonly referred to the later Pliocene; but the single implement tells little of the habits and customs of the people it represents, save that they had advanced far in the art of stone-chipping. Gilbert's hearth was located on the southern shore of Lake Ontario, when it was greatly expanded by continental tilting and obstruction of its present outlet by the later Quaternary glacier, and was buried beneath lacustral deposits when further tilting of the land altered the position of the lake-shore; and since the lake was confined on the north and east by the *mer de glace*, the temperature of the times must have been low and the surface of the water dotted

* "American Naturalist," xxi, 1887, pp. 458, 459.

by floes and icebergs in spring-time, if not all the year round. The hearth itself tells only that its builders knew the uses of fire, and constructed rude fireplaces, but is silent as to their knowledge of water-craft, as to their implements and utensils, as to whether they were hunters or fishermen, and so as to nearly all of their habits and customs. Miss Babbitt's quartz-chips appear (though the geologic relations are somewhat obscure) to represent the site of a primitive workshop or rendezvous on the banks of a river heading in the ice-sheet a few miles or scores of miles up-stream. The artificial origin of the chips has been disputed, and is indicated by their concentration in a certain local stratum and their absence from contiguous strata and other localities rather than by their form—the distribution being apparently explicable only on the hypothesis that they were artificially accumulated, whether or not they were artificially fabricated. The rude chips throw no light on the habits, customs, or environment of the men

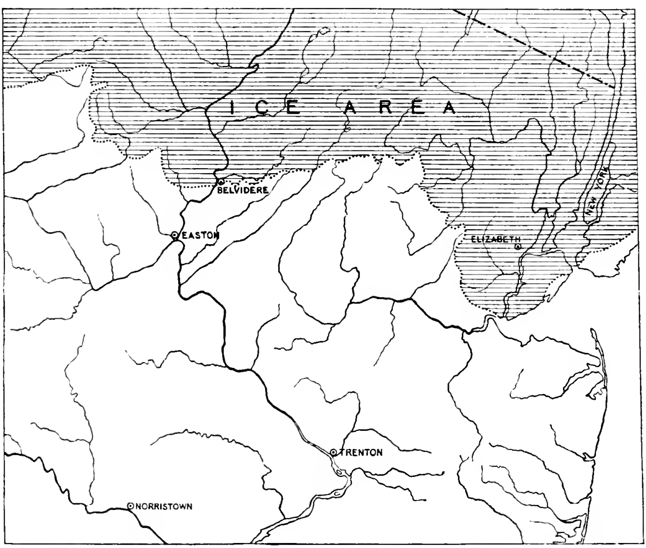

Fig. 2.—Margin of the later Quaternary Ice-Sheet in the Valley of Delaware River.

by whom they may have been fashioned, save that, if artificial, they exhibit the lowest known grade of culture; but this testimony of the quartz-chips is apparently antagonized by that of the polished-stone axe and disk, the copper spear-head, etc., recorded by N. H. Winchell from another part of the same terrace-plain.

The deposit in which the Madisonville implement was found by Metz was laid down by a turbulent ice-bearing river but a few miles from the glacier's margin. The implement, unlike those recorded by Aughey, McGee, and N. H. Winchell, is of the rude type commonly called paleolithic, and thus indicates primitive customs among its makers; but neither alone nor in conjunction with the similar implement found by the same individual under like conditions at Lovelands does it tell whether the inhabitant of the ice-front in the Ohio valley was hunter, fisherman, or husbandman, troglodyte, nomad, or house-builder; and only the geologic evidence suggests conditions of life approaching those of the modern Esquimau.

When the primitive man of Trenton flourished, the later Quaternary *mer de glace* covered New York and New England, and extended far into northern New Jersey and Pennsylvania. The ice was from five hundred to one thousand feet in thickness near its margin, and overflowed the highest mountains, though they somewhat impeded its progress; the land beneath was somewhat depressed and was tilted northward toward the ice-front; and flooded rivers, born upon and beneath the edge of the ice-sheet, swept into their lower courses and into the sea, glacial mud, sand, and pebbles, while upon their surfaces floated ice-floes laden sometimes with larger pebbles and anon with great bowlders. Among these rivers was the Delaware, which was transformed in its middle course from a constricted torrent rushing swiftly over a rocky bottom (as it is to-day and as it was anterior to the second ice-epoch) into a broad slack-water estuary, tidal probably to the mouth of the Lehigh. This estuary found its source at the edge of the ice, where now lies the terminal moraine (just below Belvidere); and at what is now the head of tide at Trenton it embouched into a broad, shallow bay. At the ice-front it gathered a harvest of cobble-stones which were washed down-stream and deposited in a series of terraces more than one hundred feet in height and two miles or more in width, extending ten miles down the river; the cobbles growing finer and finer and finally passing into beds of gravel and sand. There, too, the waters became charged with glacial mud—the rock-flour forming the grist of the glacial mill—which was more slowly deposited in the form of fine loam sometimes enveloping the cobbles and abundantly intermixed with the finer gravel and sand as far south as Philadelphia, but most abundantly above Trenton. There, also, the river gathered sand, fine and coarse pebbles, great bowlders, and heterogeneous *débris*, which were frozen into ice-floes, floated gently down-stream, and dropped as the floes melted, equally far southward, but most abundantly where the river embouched into the bay and where the floes lingered longest in the slackened current. These aqueo-glacial deposits extend continuously from the terminal moraine to Philadelphia. They are most conspicuous in the great gravel terrace just south of Belvidere, gradually diminish in volume and height and even merge into the modern alluvium by which they are in part overlaid between Easton and Trenton, become conspicuous again at Trenton (where they cover an area of fully fifty square miles, and are exposed in every natural and artificial excavation below their maximum altitude in and near the city), and finally disappear near Bristol, though the cobbles are largely dredged from the channel to and beyond Philadelphia. They are in part overlaid by modern alluvium, into which they appear to merge midway between the moraine and Trenton; and they repose unconformably upon the greatly eroded surface of the Columbia formation—the aqueo-glacial deposits of the earlier cold epoch of the Quaternary—notably at Trenton, where they fill a basin lined with Columbia brick-clays and gravels.

By structure, composition, and topographic relations the deposits tell the story, as by their geologic relations they fix the date, of their origin. At Trenton the deposits consist of stratified gravels more heterogeneous than, but otherwise undistinguishable from, those of the terraces into which the terminal moraine merges, interspersed with bowlders up to one hundred cubic feet in volume, the whole imbedded in a matrix of sand and loam. The entire mass is unquestionably water-laid; its continuous bedding is indicative of wave-action, and thus of shallow waters; and the bowlders scattered throughout it are evidently ice-borne. Its structure is shown in Fig. 3, reproduced from a photograph taken in the extensive gravel-pit half a mile east of the depot at Trenton. The relations of these gravels to the subjacent Columbia formation are shown in Fig. 4, also reproduced from a photograph taken at Chambersburg—the coarse, stratified gravels,

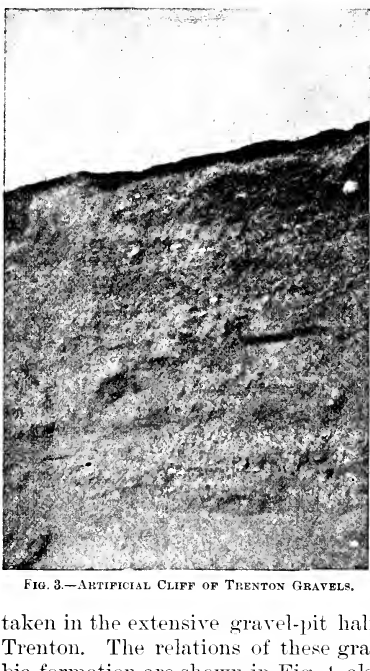

Fig. 3.—Artificial Cliff of Trenton Gravels.

bowlders, etc., representing the later deposit, and the homogeneous loam passing downward into coarse gravels representing the older formation. The thickness of the deposit ranges from a trifling veneer to forty feet or more; and its surface, where it has escaped erosion, forms a plain inclined gently southward from an altitude of about forty-five feet in north Trenton to tide-level midway between Bristol and Philadelphia; this inclination of the deposit being the measure of the northward tilting of the land during the later ice epoch.

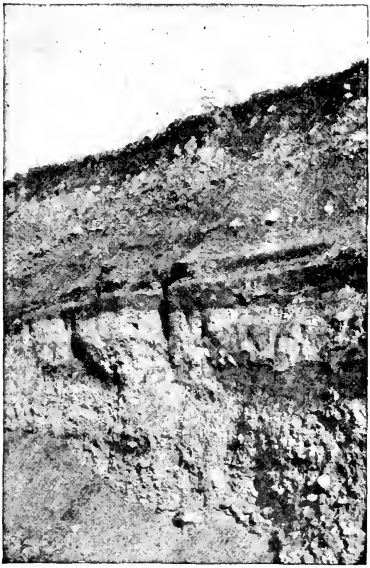

FIG. 4.—TRENTON GRAVELS LYING UPON COLUMBIA LOAM AND GRAVELS.

Within the Trenton gravels two types of implement are found—viz., "turtle-backs" and the rude "leaf-shaped" implements regarded by Abbott as of Esquimau pattern. Both types are chipped from a peculiar argillite which is found in the deposit only as (presumptively) finished implements or as large bowlders. The implements, which occur in such numbers that over twenty-five thousand have been collected by Abbott, are seldom water-worn though frequently weathered, while the bowlders are somewhat worn by water and similarly weathered. It is significant that the "turtle-back" type is found throughout the deposit from top to bottom, but most abundantly in the lower half and in progressively diminishing abundance from bottom to top of the upper half, while the "leaf-shaped" type is found only in the upper half and in progressively increasing abundance upward; it is also noteworthy that both types of implement are occasionally found over contiguous surfaces of the Columbia formation (which were above water-level when the Trenton gravels were deposited), commonly associated with chipped implements of higher type; and it is equally noteworthy that the implements of higher type occur over the surface of the Trenton gravels but never within them, while the ruder implements found within the gravels do not occur upon the gravel surface.

The geologic evidence of the environment of the celt-users of the Delaware River is complete and intelligible: the continuity of the deposits proves that the Trenton gravels were laid down while the northern part of the country was occupied by ice, and while

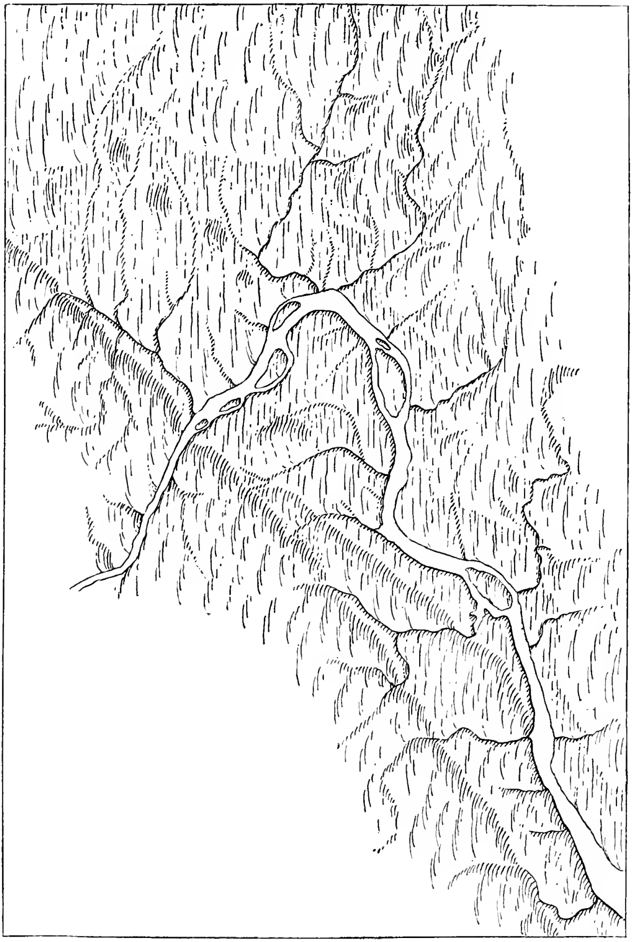

Fig. 5.—Stereogram of the Present Head of Delaware Bay.

the terminal moraine was forming; their structure and composition prove that they were laid down in shallow floe-bearing waters; their distribution indicates unmistakably the geography of the period; and this physical testimony is corroborated by the association of remains of extinct or boreal animals (mastodon, reindeer, bison, etc.) with the human relics. So definite, indeed, are the data, that the geography of the period may be depicted

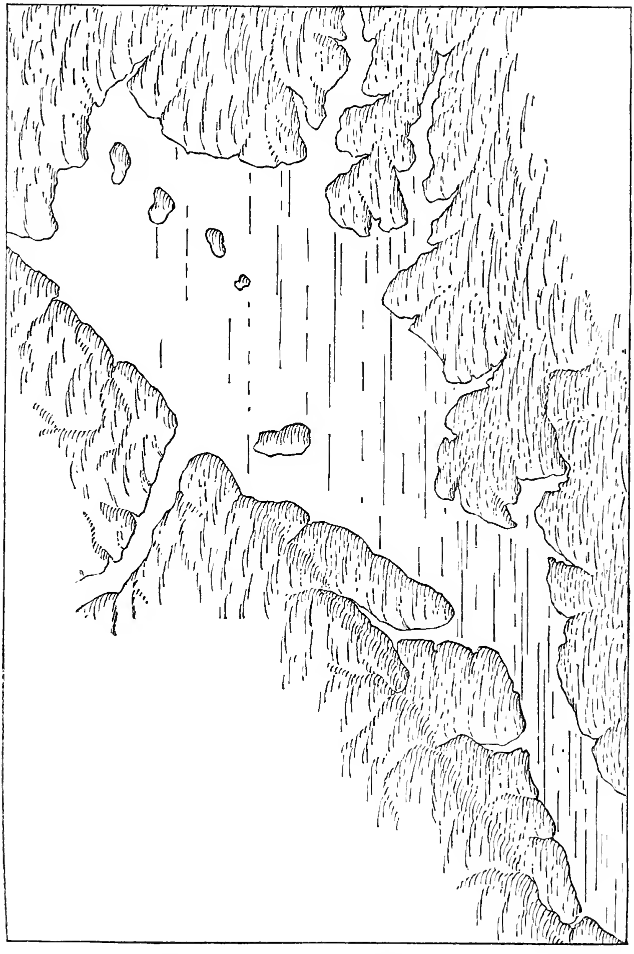

FIG. 6.—STEREOGRAM OF THE HEAD OF DELAWARE BAY IN LATE QUATERNARY TIMES.

graphically. Fig. 5 is a bird's-eye sketch of the present head of Delaware Bay, based upon the admirable topographic surveys of New Jersey and upon personal studies, and represents with reasonable accuracy the general features of the region; and Fig. 6 is a similar sketch of the region as it existed during the Trenton gravel period, based upon the same surveys and upon the shore-lines brought to light thereby, and probably represents the configuration of the earlier period with equal fidelity.

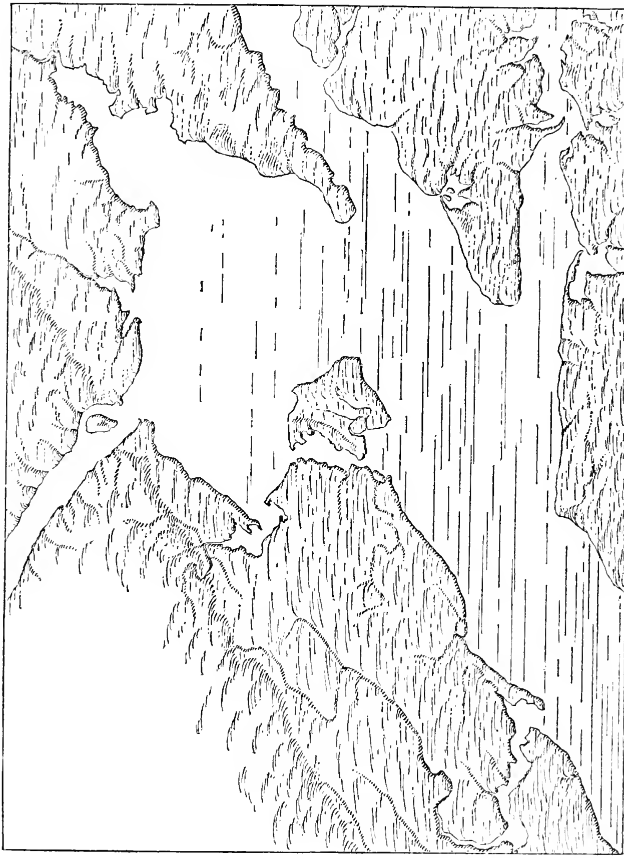

FIG. 7.—STEREOGRAM OF THE HEAD OF CHESAPEAKE BAY.

Fortunately, the Delaware Bay of the later Quaternary has an existing homologue by which conceptions of the local physiography and the attendant biotic conditions may be rendered tangible—viz., the head of Chesapeake Bay, shown in Fig. 7. This estuary is broad and shallow, as was the Delaware estuary during the glacial period; it is gorged in spring-time with ice-floes formed within its own area and swept into it by its great affluent, as was the ancient Delaware throughout a longer and more rigorous winter; and its bottom is a submerged terrace-plain of loam, sand, and gravel differing from the Trenton gravel only in the less proportion of ice-borne materials within it. In the shoal Susquehanna-Chesapeake estuary grow a great variety of aquatic plants, harboring multitudes of minute animals, which together furnish abundant food for fish and water-fowl, and just as it is now among white men a far-famed fishing and hunting ground, so it was a notable resort of the aborigines, as attested by the village sites about its shores; and since its shallow waters may be waded over half its area and the simplest water-craft outlives the low billows of its storms, the primitive spear-head and stone sinker doubtless underlie the cartridge-shell and leaden sinker of the present, just as the "turtle-back" of Trenton underlies the finely chipped flint of the surface. During the later ice epoch of the Quaternary the climate of the Delaware estuary was less tolerable than that of the present Chesapeake estuary, but other conditions were more favorable to concentration of piscine, avian, and human life within and about it. There the river-breeding fishes were stopped in their instinctive ascent toward former spawning-grounds to increase their kind; there the migratory birds must have ended their vernal journeyings to nest and hatch; there also the flora, forced southward before the advancing ice, must have grown mixed and varied; there the land fauna, pressed by the northern cold and attracted by the forage and carnage, must have lingered and multiplied; and there primitive men must have congregated and dominated over all. It is true but not surprising that the fragile remains of fish, fowl, plants, or even human bones have never been found in the porous and thoroughly leached Trenton gravels, associated with the implements and the more massive bones of mastodon, bison, and reindeer; but the locality was as distant from the ice-front as the arctic breeding-grounds of to-day, and moderately mild climate is attested by the wonderfully abundant implements and the numerous population they represent.

The artificial origin of the "turtle-backs" has been questioned, and their abundance has been regarded as proof of their natural origin; and it is therefore not a work of supererogation to point out that the Trenton gravels are largely wrought for railway ballast, and have been scanned by the thousand tons by eager workmen with the hope of reward before their eyes, and to repeat that the argillite of which the implements are fashioned rarely occurs in the deposit in the form of natural pebbles. Of any hundred bits of argillite selected at random from the gravel-bank or the collection, ten per cent to thirty per cent exhibit unmistakable traces of design, a somewhat larger percentage suggest but do not prove design, and not more than fifty per cent strike the student as natural, when the individual specimens are examined separately; and when examined collectively the correspondence in form and mode of fracture between symmetric "turtle-backs," "failures," "spawls," "chips," and miscellaneous fragments compels the cautious geologist to question whether any are demonstrably or even probably natural: the series is not from the certainly natural to the doubtfully artificial, but from the certainly artificial to the doubtfully natural.

The "turtle-backs" tell nothing of the customs of the makers, since their function is unknown; whether they were sinkers for nets, whether they were hammers or axes used either in the hand or attached to withes or handles, whether they were used as the *bolas* of the Patagonians, whether they were employed in fishing, first for cutting the ice and then for eviscerating and scaling the fish, or whether they subserved a variety of purposes, remains undetermined. The environment read from geology indicates that the Trenton man was a hunter or fisherman who used and lost the primitive tools of his mysterious craft within the waters rather than upon the land, and thus appears to materially narrow the range of hypothesis as to his activities; but the extravagance in labor indicated by the vast numbers of unworn implements suggests that the rapid modification in environment and occupation accompanying the ice-invasion outran the resulting modification in appliances, and that the implements were really invented on land and were but ill adapted to the new conditions; and the introduction of a new type of implement during the brief epoch of gravel deposition gives support to the suggestion.

So the margin of the cloud enveloping the beginnings of human life in America is slowly lifting. Already there is definite and cumulative evidence of man's existence during the latest ice epoch, with a strong presumption against an earlier origin than the first Quaternary ice-invasion; already it is known that the primitive American haunted the ice front rather than the fertile plain, and must have been hunter or fisherman; already his environment is so well known as to partially elucidate his activities; but the first traces of the autochthon yet found tell of an intelligent being who dominated the animal world as does his descendant, and thus the mystery of man's ultimate origin remains enshrouded as darkly as ever.

HABITS OF THE GREAT SOUTHERN TORTOISE.

By N. S. SHALER,

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IN a recent paper published in "The Popular Science Monthly" for February, 1888, I called attention to the effect on the soil produced by various burrowing animals. At that time I had not seen the work done in the under-earth by the *Gopherus Carolinus,* the largest of our North American tortoises, a creature which, on account of its peculiar habits and the geological effects which it brings about, is worthy of an attention which it has not received. It is a well-known fact that land-tortoises are particularly abundant on the American continent. Though found elsewhere, and once extremely abundant in other lands, they are now most plentiful and of largest size in the Americas, and the Galapagos Islands, off the western coast of South America. The greater part of these creatures have the habit of spending the most of their lives on the surface of the ground, only resorting to the under-earth for occasional shelter or during the annual period of rest or hibernation. The gopher, on the other hand, has developed the habit of underground life to such a degree that it may fairly be reckoned as an essentially subterranean form. The greater of our Southern species, and the one to which I shall devote this paper, dwells for the greater part of its life below the surface, only coming occasionally from its burrows. It appears to be by far the largest species of our vertebrates which is normally subterranean in its mode of life. The region at present occupied by this species is narrowly limited; it includes, so far as I have been able to find, only the southernmost part of our Gulf States, the southern portion of South Carolina, and the seaboard region of Georgia, Alabama, and Florida. Within this considerable area it is limited to the regions of the sand-plains, for in those districts alone does it find the soil suited to its peculiar habits.

The gopher, it should be noted, is of considerable bulk, having in adult specimens a length of fifteen inches or more, a width of about twelve inches, and a thickness from the breast to back of from eight to twelve inches. At first sight of the creature, it seems as if its form was totally unfitted for underground movements. The front of the animal is very blunt, and calculated to oppose about the maximum of resistance to movements through the earth. The fore-limbs are not to any degree specialized for grappling with the earth which has to be moved to form the burrow, and the head does not differ from that of our ordinary turtles and tortoises, which is fitted for grasping prey and not at all specialized for use as a shovel or digging instrument. A very slight examination of the sandy woodlands which are principally occupied by this creature will, however, convince the observer that the gopher, though selective processes have not helped him in his arduous task, is by dint of sheer strength and admirable persistency capable of doing work of singular magnitude.

The traveler in Florida may notice even from the windows of the railway-train that all over the surface of the soil in the pine-woods lie little heaps of sand which contain about one half a cubic foot of material which has been thrown upon the surface since the last period of rains. Sometimes there are only a dozen or two of these heaps to the acre, but they often amount to as many as two hundred or more in that area. Where they are few in number, we may remark that they are distributed in a tortuous line. Where they are very plenty, these tortuous lines intersect each other in such varied directions that no order in the distribution of the hillocks is discernible. Closer observation will show that these heaps are thrown out upon the burrows formed by the gophers. At first it might be supposed that they represented the points of entrance or exit of the subterranean passages, for it seems possible that the soft sand has fallen down over the opening so as to conceal its original position, and thus give the accumulation the aspect of a mere heap; but if the student takes pains to dig down into these little mounds, he will find that they do not communicate directly with the burrows. It is generally impossible to trace in the loose sand the manner in which they have been thrust up to the surface.

A little careful searching will show the way in which these curious mounds have been formed. Here and there, but rarely perhaps in one amid a hundred of these mounds, we find the place where the reptile entered the ground. This opening is at once seen to be quite separate in character from the mounds which first attract the eye. It consists of a clearly defined tunnel, the sides commonly somewhat smooth and compacted by the energy with which the body of the creature has been driven through it. The passage inclines steeply downward, descending at the outset at an angle of from 20° to 30°, then turning at the depth of two or three feet to a more horizontal position. On the surface, a little beyond this entrance, is a heap of *débris*, which consists of the sand taken from the passage. A few feet in from the opening, the passage appears to be closed by loose material which was not ejected from the mouth of the tunnel. Although I have been unable to catch these tortoises at work, I have succeeded by tolerably safe inferences in tracing their method of operation. When they begin the burrow, they endeavor at once to penetrate downward to the level in which they obtain their food. At the outset they manage, by frequently backing out of the passage, and thrusting the earth behind them in their retreat, to clear a considerable opening. When they have advanced a few feet in the excavation, they cease to discharge the material excavated in their advance, but thrust it behind them, and leave it lying in the chamber, which it entirely closes. With this storage-room provided, the gophers are able to advance through the earth for the distance of some yards; but as the earth compacted by its own weight, by the pressure exercised through the expansion of roots, and the action of the rain, occupies less space than the same material loosened in the progress of the burrow, they soon become hampered in their movements. They then turn toward the surface and continue the excavation upward until they have attained very nearly to the open air. They then use the great strength which they clearly possess to thrust a quantity of the burrowed material upward until it rises above the surface in the form of a cone, and by the space in the burrow thereby gained they are able to go a few feet further in their tortuous line of advance, when they must again seek to discharge a portion of the earth in the manner just described. So the creature proceeds in its devious underground way, coming near the surface and pushing out a portion of the sand at intervals of from two to five feet in its path. In this manner it appears to journey at times for a distance of hundreds of feet before it again has occasion to come to the open air.

For the greater portion of its journey, the path of this creature seems to lie within two or three feet of the surface, that being the level in which it finds the roots which afford it food. It appears, however, from the points at which they emerge in the railway-cuts, not unlikely that they occasionally penetrate to the depth of six feet below the top of the soil. Although they plentifully occur throughout a region having a superficial area of nearly one hundred thousand square miles, they appear to exercise a considerable choice as to the ground they inhabit. They demand, in the first place, that the water-level shall not be within a dozen feet of the surface, and that the material they traverse shall be a very open-textured sand. This is probably because in the rainy season any considerable rise in the level of the ground-water would be destructive to them; unless they could quickly escape from their burrows, they would be drowned. It is often possible, through this habit, to determine in an approximate way the depth of the Tertiary beds of clay and other indurated materials which at many points lie near the top of the sand which envelop the surface in the Southern States. Where these beds, too compact for the uses of this creature, come within a short distance of the surface, they avoid the ground.

The geological effects of this creature in the district which it inhabits are considerable. In a region extensively occupied by them, they turn over the earth, to the depth of some feet, with amazing rapidity. On selected areas chosen to represent the work done by these animals I found that the number of hillocks varied from fifty to two hundred to the acre, and that the heaps contained an average of rather more than one fourth of a cubic foot of sand when reduced to the measure of compactness which it occupied when in its original place. I came to the conclusion that it would be safe to estimate that in each year this soil matter thrown up by the gophers on the surface of an acre amounted to an average of fifty cubic feet, the greater portion of which was uplifted from a depth of a foot or more below the surface. At this rate they would completely overturn the soil, for the depth of a foot or more, in about eight hundred years. In addition to the effect produced by the process of throwing out the earth upon the surface, these creatures accomplish a vastly greater amount of subsoiling by continually ascending and descending in the earth, pushing the earth behind them as they go. I am inclined to think that they displace vertically, about the amount of a foot or more, all the sands to the depth of about three feet in the course of less than a century. The result is, that in the regions they occupy there is no distinct soil coating whatsoever; the thin layer of half-decayed vegetable matter, rarely exceeding an inch or two in thickness, lies immediately upon the sands, which are scarcely commingled with the humus material. Although the rapid decay of vegetation in the warm climate of the South may in part account for this peculiarity, I think that it in the main is due to the action of these creatures. This view is supported by the observation as to the character of the soil in places where the gophers have not done their underground work. Thus, where the ground is too wet for their occupancy, we commonly find a thick coating of vegetable matter and a soil which is charged with humus to a considerable distance from the surface. The wet "hammock" or "hummock" lands, which exist as occasional patches in the sandy districts where these animals are plenty, apparently owe in good part their more normal character of soil to the exemption from the overturning of the superficial materials which these creatures effect.

There is another important way in which these gophers have influenced the geological conditions of the districts they inhabit. The sands through which they make their burrows have evidently been deposited by water-action. They were probably originally in the stratified form, but so thoroughly have they been overturned to the depth of several feet by the burrowing of these animals that no trace of this original structure is shown in the railway and other cuts except where by a rare chance the section is so deep that it penetrates below the level of their migrations. At first sight I was greatly puzzled to find that the superficial sands of Florida, which have evidently been deposited beneath the sea, exhibited no trace of stratification, which is invariably brought about in deposits formed in shallow waters subjected to a strong current action. It was only when I came to reckon on the influence of these creatures in destroying the original planes of stratification that the riddle became plain. So far as I am aware, this is the only case in which a burrowing animal has done so much work as practically to efface the stratification planes in a wide field of sedimentary deposits. It appears to me likely that the absence of fossil remains in these superficial sands of Florida may be explained by the endless stirring of the beds which these creatures have effected. It is evident that in their motion through their underground ways they have exercised a very considerable degree of violence. A fossil which might have remained well preserved in undisturbed beds would, from repeated contact with the strong claws of the gopher, have been broken into fine bits, and made ready to pass into the state of solution. As is well known, ordinary marine fossils deposited in porous sands soon become very frail, and would certainly not resist any such rude treatment as they must again and again have received at the hands of these animals. The railway and cliff sections of Florida, which afford us the only opportunities for a careful examination of the superficial sands, are in positions where they are accessible to the gophers. In an examination of a good many miles of these escarpments, I found only one or two points in which a trace of the original bedding appeared to be distinguishable. It is evidently difficult to account for the unstratified as well as the non-fossiliferous nature of this deposit in Florida without some such explanation as that to which our study of the gophers leads us.

To the student who wishes to ascertain the limits of evolution under the influence of natural selection, the gophers present certain facts of great interest. It is evident, from the foregoing statements, that the habits of this creature are eminently peculiar, and yet there are no manifest modifications of the body which fit its peculiar needs. In shape the animal does not differ in any important way from our ordinary terrestrial species of *Testudinata*, which at most burrow in the earth for a little distance to secure temporary concealment or protection from cold in the hibernating season. All the most evident external modifications of the tortoise are directed to the end of securing protection against assault.* The gopher is singularly exempt from the dangers encountered by the species which normally dwell on the surface, and its needs are totally different from its purely terrestrial kindred. How is it, then, that the form remains unchanged? Clearly the selectionist has to assume either that advantageous variations do not occur, or that there is some controlling element limiting the process of variation which absolutely prevents the accumulation of these chance modifications to a profitable end. Variations do occur in the shape of individuals. They seem to be about as plastic as other vertebrates in this regard. Here we must throw out the idea that the failure to produce advantageous modifications is due to the lack of variety on which selection can work. We are therefore reduced to the question-begging of which many naturalists now avail themselves in considering this process, and are compelled to say that there is a certain rigidity in the organization of the animal which prevents the accumulation of beneficial variations. This explanation is substantially like that of the doctor in Molière's play, who explained that "opium put people to sleep because of its soporific virtue"; but this does not suffice in the present case. It is worth while to note in this connection that, although the habits of the gopher have varied little with their peculiar habit of life, they have invented, as before noted, the very sufficient and ingenious custom by which they discharge the surplus earth from their burrows at the least expenditure of force and time. This peculiar intellectual adaptation appears to me one of the most interesting features connected with the life of this interesting animal.

To the question, sometimes raised, whether in the existing profusion of books and newspapers, making the direct taxing of memory less necessary than formerly, the powers of that faculty may not be depreciated, it may be answered that, though we no longer depend upon the memory as our only register of facts, we still use it more than the ancients did. Our knowledge travels over an immeasurably wider area, we have more to remember, and with continued advancement of civilization a good memory becomes more needful for the work of life. Our general intelligence and powers are improving, and memory is sharing in the general advancement.

* The only peculiar modification of the gopher's shell which can be deemed the product of selection with reference to its peculiar habits is the share-like projection of the plastron or lower shell, which is directed forward, and possibly serves in a slight way to divide the earth at the bottom of the burrow over which it crawls. My friend Mr. S. W. Garman, who has kept one of these creatures in captivity, has observed that the animal, by tilting the body downward at the anterior end, can project this share under the edge of a stone or into the crevices between two boards, and exercise a considerable amount of disruptive power by this process. If these creatures made their burrows in stony ground, it might be possible to conceive the structure as advantageous, but as they work altogether in fine-grained soils, I can not conceive that this curious projection is of any functional value.

EVERY-DAY LIFE OF INDIAN WOMEN.

By Captain RICHARD CARNAC TEMPLE.

ONE of the chief characteristics of Indian domestic polity is extreme subdivision, and the tendency among all classes of the natives of India is toward the social isolation of groups with contracted interests, and the consequent accentuation of minute differences in habits of life. The results of this are what is generally known as "caste," and it is caste that underlies and controls all social matters that are peculiarly Indian. At first sight, therefore, under these circumstances, there can be no such thing as a common method of life among the women of a population which is an ill-assorted compost of wild and savage tribes of diverse origin; of Brahmans and orthodox Hindoos; of heterodox Hindoos and Brahmanists by conviction and birth; of Buddhists, and Jains, and Parsees; of Mohammedans, and Jews, and Christians of long standing; of Aryan and Dravidian races; of aboriginal clans of Aryan and non-Aryan descent; of highly cultivated communities and completely ignorant tribes; of whole peoples within and without the pale of Oriental civilization. But, nevertheless, there exists a standard of life which is Indian, and to which all the varieties of the natives of India are drawn—just as there is a life which is Oriental in the usually restricted sense of that term, habits that are Indo-Chinese, and manners that are European. No one supposes that Norwegian and Italian ladies live exactly in the same way, or that English and Spanish women adopt precisely the same mode of life; but that there is a general line of conduct which is common to all European countries is apparent to every one who observes mankind. So it is in India. And the overshadowing influence to which every true native of the great peninsula unknowingly submits is that wielded by the modern Brahmans through their stanch henchmen, the high-caste Hindoos. In describing, therefore, in very general terms, the aims and habits of an ordinary Brahmani, one can give a fair notion of a life which every Indian woman, however antagonistic her creed and race, is unconsciously led on by instinct, as it were, to imitate, and which is her invariable model.

Habits of life are enormously, if not mainly, influenced by religion, and this leads me to say a few words here regarding Brahmanism as a living and active faith, though it has been the fashion in certain authoritative quarters to look on it as dying, if not already dead. Granting that it is not a proselytizing, in the sense of being a missionary, religion, and granting that its fundamental theory—it is only a theory and not a practice, be it remembered—is, to parody a well-known saying, that *Hindoo nascitur non fit*, still there can be no doubt that it manages to make more converts by mere assimilation than can any other religion in India by direct missionary effort. This absorption into Brahmanism is becoming, under the *pax Britannica*, day by day, a more important feature in Indian social economy. As surely as the English bring fresh uncultured tribes under their civilizing influence, so surely do they add to the number of the Hindoos; as surely as the iron hand of Anglo-Indian law, by refusing to recognize any difference between man and man, causes the upward rise in the social scale of those that labor to good purpose, so surely is the cause of Brahmanic orthodoxy advanced and its influence widened. I have watched the first process myself in the case of the recruits to our little army of Gurkhas; the wild mountain boy, on joining his regiment, is taught not only his drill, but also the Hindustani language as understood in military circles, and with it his religion, i. e., a smattering of current Hindooism. The second can be seen in progress any day all over India, by any one who will take the trouble to observe the career of a successful handicraftsman or small trader. At first an "outcaste," dealing only in matters of religion with his tribal soothsayer; as he gathers money, he sets up a Brahman priest, and minds the orthodox gods, and at last, when respectable and wealthy, he develops into a full-blown Hindoo; and then, since in all Hindooism ceremonial orthodoxy is synonymous with social respectability, he adopts Hindoo manners to the full; isolates his women, prohibits the remarriage of widows, marries off his infant children in the proper quarters, and practices the thousand-and-one customs peculiar to his adopted religion. Of course, in order to be able to thus attract to itself so many antagonistic principles of custom and belief, the modern Brahmanism can have no hard and fast creed. It has, in fact, no creed at all, properly so called. Nothing in the shape of "I believe in God the Father Almighty"; nothing like the strict Mohammedan formula —*lá iláha ill' illáhu, Muhammadi-'r-Rasúlu'-lláhu* (there is no God but God, Mohammed is the prophet of God). It consists rather of a leading principle, viz., to gather together whatever items of belief may come to hand, in order to develop them in a certain definite direction, under the control of its own priests, and for their benefit; and while the process of development is going on, it naturally ingrafts its own customs on to those it already finds in existence. Herein lies its wonderful vitality and strength, its capacity for digesting anything that it gets into its maw, and its power of resisting internal disruption. The apparently elastic network of caste and family customs that it invariably twines round its victims is marvelously cruel, and so unendurable that revolt after revolt has been made against it; but the result, so far, has been only to loosen the meshes for a time. Slowly and surely the intangible threads have tightened again, as by degrees the very customs created by the schismatics are adopted by its priests, and made to conform to the general theory—all the harder to resist because it is never formulated. The bulk of the Mohammedans of India, being descendants of tribes converted wholesale in various ways to Islam in days gone by, are still Hindoos in many matters of thought and custom. In fact, if we extract the profession of faith and a few formulæ, it is not at all easy to say, as regards them, where Islam begins and Hindooism ends; in any case Brahmanism overshadows their lives. The Jains, at least that important section of them known as the Saraogis, are separated from Hindoos proper rather in sentiment than in fact; and though the Parsees, Jews, and Christians have greater powers of resistance yet it would not be difficult to show how greatly the all-pervading faith of Hindoostan has influenced them too. Many a missionary could tell a tale of more or less ineffectual battle against the notion of existence of a Christian "caste." Of course, I am not now speaking of the tenets deliberately held by the authorized exponents of the several rival creeds, but of the religious ideas of the unintelligent masses, which are to my mind the outcome of an unthinking reverence for things usually held to be holy, i. e., hagiolatry, whatever be the outward expression of faith. Of such a state of things Brahmanism is pre-eminently adapted to take full advantage, for it presents no bold front to prejudices, and bends no man to its will, but rather puts forth its tender tentacles, gradually draws to itself, and quietly absorbs all things.

I would not have it inferred, from what has been just said, that I hold all the women of India to lead practically identical lives; that the secluded banker's daughter has much in common with the scavenger's wife, free to go where she pleases and to speak to whom she will; or that the worthy spouse of the village Maulavi would not at once flare up and feel highly insulted if told that her life was conducted on much the same lines as that of the Panditani over the way. It would be more than erroneous, moreover, to state that a woman of Kumaun has exactly the same views of propriety as she of Mahabaleshwar, or that the grimy Panjabi has manners similar to the oiled and carefully bathed inhabitant of Madras. All I wish to assert is, that a special way of living underlies all those differences which appear so great to the casual observer, and that beneath the chance-tossed waves on the surface there lie hidden depths of female life which are distinctly Indian, and which can be best sounded by a study of the high-caste Hindoo women.

I can not enter into the details of the life of orthodox Hindoo women. Nothing more, indeed, can be done now than to indicate its merest outlines, in order to show of what it mainly consists, whither it tends, and how it affects those that lead it. Hindoo exclusiveness absolutely prohibits outsiders from personally observing what I am about to describe, and all that can possibly be done by persons such as I, is to procure our facts as nearly at first hand as practicable. Hence the necessity of explaining briefly what the sources of my information are. Chiefly, then, I have drawn upon matters which have come to me as the first hearer of the tale; partly because I am quite sure that all the facts thus learned are straight from the mouths of trustworthy natives of India, and partly because I should be sorry to be, by any mishap, a misinterpreter of other people's writings. Although I shall not be wittingly guided by any one of them, there are several works of original information, more or less directly bearing on my subject, which all who are interested in it would do well to study. Among these are "Hindoos as they are," written, indeed, by a Christian convert with something of the convert's proverbial asperity toward the followers of the religion he has discarded, but containing much that is valuable to the student; "The Hindoo Family" of Balram Malik, a far superior work to the last, by the well-known Judge of the Calcutta Small Cause Court, who has treated his subject as only he can, that is, in full sympathy with it, and, of course, with complete knowledge; and "The Life of a Hindoo Woman," by the celebrated Brahmani Ramabai, who was driven to Christianity at last by the persecution of her co-religionists. For Mohammedans, there are Dr. Herklot's "Quanoon-e-Islam" and "Notes on the Indian Musalmans," by the wife of Mir Ali Hasan, who was an Englishwoman. And then there are several collections of folk-songs—notably Gover's from southern India, and Grierson's from the north—which, between the lines, contain facts about Indian women that none can gainsay. However, I shall now confine myself to statements based, firstly, on notes supplied me by natives for "Panjab Notes and Queries," which I have edited from the commencement; secondly, to the late Dr. Fallon's splendid collection of "Hindustani Proverbs," 12,500 in number, which I commenced editing and translating in 1883; and, thirdly, to the various collections of folk-songs that I have made and published at different times within the last eight years.

An Indian woman's life in its ordinary course is divided into two clearly defined parts, which are quite distinct, though separated from each other only by the fateful day on which she first goes to take up her abode within her father-in-law's family. Note that it is not called in the Indian languages her husband's family, for that, under the Indian family system, it can seldom be in the case of a bride. Childhood rather than girlhood is the heyday of the Indian woman. Free to play as she pleases, with plenty of companions, for children galore can hardly ever be wanting in a family which all live together, from oldest to youngest; free to run in and out of the houses of friends, never bothered to learn anything except what she can pick up from the women about her, never worried with caste restrictions, never asked to do more in the way of labor than to help in the house-work, petted by her parents, spoiled by her aunts and uncles, and beloved by her brothers, an Indian girl-child is indeed happy—as children count happiness. And then suddenly the curtain falls. At about ten years of age —earlier in some parts and later in others—our spoiled child is old enough to work in earnest, and so she is packed off, sorely against her will, to join her husband's family, entering it not as our brides enter their future homes, at the head of the female community, but at the bottom. Child though she still is, her childhood is now forever past, and she is turned into a young woman, only too often into by no means a happy one.

At this stage it is necessary to consider two matters, so far as they affect an Indian bride, viz., the practice of infant marriage, and what is known as the joint-family. I need hardly state that the so-called "marriage" of infants is practiced among all classes in every part of India, though of course there are many exceptions to the rule. The term "marriage," as applied to this ceremony by us, is, however, rather misleading. It is in reality an irrevocable betrothal—a bargain not between the infants who are "married," but between those who control them, being often nothing else than a purely commercial contract. It arises out of the theory that a woman is for life under tutelage, and her "marriage" is, therefore, merely a transfer of the right over her to another party, a transfer naturally very frequently made in return for a pecuniary consideration. After this marriage or betrothal, the girl usually remains with her parents, in trust for those to whom she is to be transferred, until the home-coming or going to her husband's house, which may be looked upon as the real marriage, as we Europeans use the word. Until the second ceremony takes place the child-wife is still a child to all intents and purposes, and treated as such, and it is only after it that she in any sense enters on the duties of female life. The family she joins is exactly like that she has left, only it is that of another; to her a vast difference, and one which she never forgets—indeed, it is not unfrequently made painfully apparent to her at every step. What I may call the regulation Indian joint-family is one composed of the *paterfamilias*, all his sons and brothers, and various extraneous relatives, such as nephews, cousins, and wife's kindred, for the male part; and all their wives, in addition to his own wife and daughters, together with a sprinkling of the family widows, for the female part. In this patriarchy there are grades upon grades, both male and female, dependent chiefly upon age and distance by blood from the head of the family; and as everybody is married in India as soon as the time for it comes, the chances are that the last-made bride is, in the nature of things, in the very lowest place.

In the average Indian family the strictest domestic economy is the rule of life, and the household work is done by the women of the household, not, as with us, by paid servants. Servants there are, of course, in all Indian families, but they are, as a rule, on a totally different footing from the European domestic, being for the most part independent persons with a *clientèle*, for whom they perform certain customary services for a customary wage. The distribution of the daily work, down to that of the most menial kind, lies with the *materfamilias*, who may be best described as the oldest woman in the family proper under coverture, for widows can have no authority. The cooking, as the work of honor, she keeps to herself, but the house-cleaning, the washing, the care of the children, the drawing of the water, the making of the beds, and so on, is done by the less dignified members of the household, as she directs; and whatever is most menial, most disagreeable, and the hardest work, is thrust upon the bride. She is the servant of the very servants, and must obey everybody. It is hardly, therefore, to be wondered at that, after her previous training, it is by no means an uncommon occurrence that she has to be forcibly broken into her new way of life, that she is for ever sighing after the flesh-pots of her father's house, that there are various "customs" which enable her to revisit it at stated times after the marriage, and that the law is often invoked to oblige brides to return to their husbands' families after the customary term of such visits has expired.

Not only is our bride thus turned into a drudge, often unmercifully overworked, but from the day she gives up her childhood to the day of her death—it may be for sixty years—she is secluded, and sees nothing ofthe world outside the walls of her family inclosure. It should always, therefore, be borne in mind, when trying to realize Indian female life, what a very important thing the domestic economy is to a woman; how largely the petty affairs of the household loom upon her horizon. Her happiness or misery, indeed, entirely depend on the manner in which the affairs of the family are conducted. Now, considering that the female mind has for centuries been mainly directed to this all-important matter, it is not astonishing to find that such questions as the proper method of eating and drinking, and of domestic propriety generally—the intercourse, that is, which is permissible and right between the various members of the household, male and female—have long been regulated with the utmost minuteness. To us who roam the world at will, and whose interests are often fixed far more outside than inside our homes, it may seem remarkable that such infinitesimal restrictions and numberless customs as are found in full swing in an orthodox Hindoo household should be remembered and carried out with the exactitude demanded of the womenkind; but if we consider that these make up their whole life, and that they are called upon to pay attention to nothing else, their capacity for recollecting when to veil and unveil, whom to address and avoid, when they must run away, and when they may speak, ceases to be extraordinary. And regarding these customs of social propriety, I must say that the more one studies them the more one is impressed with their perverted ingenuity. They seem purposely invented to make the unfortunate victim of them as uncomfortable as possible. The Indian woman, isolated from the outer world by custom, is again by custom isolated as far as practicable from all the male members of that little inner world to which she is confined. Free intercourse, even with her own husband, is not permitted her while yet her youthful capabilities for joyousness exist. No wonder, then, that absence of jollity is a characteristic of the Indians generally, for the happy laughter of a home is denied them by custom in the most persistent manner.

Every person belonging to the European races, an Englishman especially, well knows how much common meals tend to social sympathy; how powerful a factor they are in promoting pleasurable family existence, and in educating the young to good manners. There is nothing of this sort in Indian upper-class society. There the men and women dine strictly apart, the women greatly on the leavings of the men, and that, too, in messes of degree, very like those in a royal naval ship. *Paterfamilias* dines by himself, then the other men together in groups, according to standing, waited on by the women under fixed rules; and lastly the women, when the men have done, our poor young bride coming last of all, obliged often to be content with the roughest of the fare.

No imported woman may have any relations with those males who are her seniors. Every bride is such an imported woman, and all the household which she enters, who are the seniors of her husband, are her seniors. This at first generally includes nearly the whole family, and must necessarily for a long while include the major part of it. In all her life she never speaks to her husband's father, uncles, or elder brothers, though dwelling under the same roof, or, to speak more correctly, within the same inclosure, for an Indian house is what we should call a courtyard surrounded by sets of apartments. On the other hand, *paterfamilias* has not only never been spoken to, but technically never even seen, by any of the younger women of his varied household, except those born within it, though they all dwell under his protection and at his expense. You will perceive, therefore, that the women's lives are contracted to within even a smaller sphere than that limited by the boundaries of the common family dwelling.

What would seem to us to be intolerable restrictions by no means end here. In many places it is not proper for a young father to fondle his own children in the presence of his parents, and highly improper for a wife to be seen holding converse, or appearing unveiled, or sitting down before her own husband, until she has become a mother.

There is another custom regarding which it is useless to pretend that it does not lead to endless misery and family squabbling—the absolute subjugation of the women to the *materfamilias*. The mother-in-law is indeed an awful personage in the eyes of her sons' wives, one against whose will and caprice it is hopeless to rebel. I can hardly describe her power better than by noticing a daily ceremony which symbolizes it. It really amounts to wishing "good-morning," is called in upper India *máthá tekná*, and consists of bowing down to the ground and touching it with the forehead. All the women, except her own daughters, perform it daily to the *materfamilias* when they first see her, and a bride must do it practically to everybody.

An Indian woman's happiness in life immensely depends on her becoming the mother of a son. This at once raises her in the family estimation, which is all in all to her; insures her against the greatest bitterness of widowhood, in case that befall her; and procures her domestic authority should she survive to mature years under coverture. *Materfamilias* is a veritable queen in her own little world, often coercing her husband, commanding her sons, and ruling the rest as she pleases. From what has come under my observation, I have long felt assured that, speak contemptuously of the opposite sex as they choose, lock them up as they may, and treat them as mere breeders of sons as they will, the natives of India are far more henpecked than they care to admit. Outside of their homes the men live a life of their own, untrammeled by considerations of the fair sex; within them they have little control, and it must be borne in mind that it is the women that have come to be such sticklers for the continuance of the state of things I have above endeavored to describe. The remarks just made apply, as above said, to the mothers of sons only. Should a woman be so unfortunate as not merely to be barren, but to be simply the mother of daughters, life goes much harder with her, especially as this is so liable to bring upon her that which (if their songs and sayings are to be trusted) the Indian women dread more than all things except widowhood—the advent of the co-wife. There are proverbs innumerable to show how very badly co-wives get on, but "a fairy for a co-wife is a devil" exhibits the mutual relation forcibly and clearly as it usually is. And when the rival wife brings forth the long-desired son, the barren woman's cup of bitterness is full, and all her hatred towards him is, to those who know the circumstances, well expressed in that most sarcastic of sayings in any language, "The son of the co-wife." No more words are wanting to the Indians to convey the expression of all uncharitableness.

As to the hard lot of the childless widow, so much has been said elsewhere, and so often, that I do not feel inclined to enlarge upon it, especially as enforced widowhood is not nearly so general as is usually made out by those who would deduce a moral from Indian manners to the glorification of the habits of Christians. It is often not prevalent among classes who conform generally to the customs I have been mentioning, and circumstances make it impossible among many that are not comparatively wealthy; but where it is the rule nothing can be more cruel, and, I feel justified in using the strong term, more revolting. Take the case of the widow from infancy: shorn of all that women value anywhere in the world, dressed in coarse clothing, deprived of her ornamenst, compelled to fast till health breaks down, made to subsist on the coarsest of food, kept out of what amusements come in the way of the rest of the household, forced into being the unpaid drudge of the family, held to be the legitimate butt of the ill-nature of all, considered fit only to amuse the children, openly called and taught to think herself a creature of ill-omen—this being the cause of all the rest of her sorrows—superstition has indeed nowhere else shown more clearly its power to pervert the reason of man. How much the women dread widowhood is exhibited to the full in the fact that to call a woman a widow is to offer her a dire insult, and from her earliest childhood a girl is taught to pray that she may die while yet the red spot of coverture remains on her forehead. In any case the fear of widowhood overshadows the Hindoo lady's life, even though she hate her lord.

However, it is no part of my business to tell a sensational tale, nor do I wish to convey an impression that an Indian woman's life is necessarily all unhappiness. Human nature in her case is as capable of adapting itself to circumstances as elsewhere, and since the ultimate gauge of permanent individual happiness is suitability of temperament to immediate surroundings, many a woman in India must be so constituted as to be quite content with the life she is called upon to lead, and in fact to enjoy it. When a girl is naturally sedate, yielding, and good-natured, of blunt susceptibilities, limited aspirations, and strong religious emotions, she will give in to her mother-in-law, avoid quarelling without effort, follow the course of life laid down for her without demur, thoroughly believe it to be the only desirable life to lead, find the innumerable restrictions imposed upon her not unwelcome, and become contented with her contracted sphere; and, if those about her happen to be kind, be quite as happy as any girl in the world. But the potentialities for misery involved in her surroundings are enormous, and, where such is the case, to argue that misery is not the frequent result would be to argue against human nature. At all events, the purview of her life is limited to a degree which it is difficult for us to realize. It resolves itself daily into this: the strict performance of petty religious ceremonies, feeding, bathing, dressing, cooking, and household drudgery, all so hedged round with minute regulations as to make each a special occupation, and to these must be added visiting and gossip during her afternoon leisure. How petty that gossip must be can be inferred from the facts already laid before you. Remember that the great majority of these ladies are altogether uneducated, that ever since they have been old enough to observe and think they have been shut out from the world, that they have no knowledge of any person or thing beyond those immediately around them except what they can pick up from their menials, and then you will have no difficulty in understanding that their interests are centered in their jewels and ornaments, their food, their personal concerns and troubles, the peculiarities of the members of their households, and, lastly and chiefly, in what social ceremonies and feasts happen to come their way, the widows being shut out from even these. If a marriage, a death, or a birth among their kindred were the only landmarks in English ladies' lives, we should soon have these occasions erected into as lengthy family ceremonies as they are in India. If the observance of Ash-Wednesday, Shrove-Tuesday, Candlemas, Michaelmas, Lady-day, May-day, and what not of our standard religious and secular feasts were the main opportunities for breaking the monotony of an imprisoned life, how carefully they would be kept, and how anxiously looked forward to! This is why all the innumerable *shankránts, ekádshís, ashthamís, náumís,* and other queer fasts and feasts are so regularly attended to in India. Indeed, female ingenuity has there long ago seized upon the many other opportunities for diversion afforded by occurrences incidental to human existence, and there are ceremonies to be gone through on every possible excuse. No phase of life escapes—childhood, puberty, pregnancy, maternity, widowhood, all come in for a share. The first tying of a rag round a boy's loins occasions a family feast, and so does the first time his hair is cut the first time he puts on the *janéu,* or sign of caste; and so on all through life. Before he is a man he has gone through sixteen sacraments, each a notable occasion in the eyes of his women-folk. Babies are put through all sorts of ceremonies, on the first, the fifth, the seventh, the fortieth, and other days after birth. They can not even see the sun for the first time, and, of course, can not be given a name, without a feast being held over the fact. As to the women's special ceremonies, they are just as numerous.

With reference to the rough sketch I have given of what I may term the normal state of things in India, I would again draw attention to the fact that I am far from saying that such is the invariable rule, or from denying that there are whole castes whose women are not secluded, and that many are educated. I feel compelled to repeat that minute and endless variation is the chief characteristic of Indian society, in case it may still be thought that my analysis of a high-caste Hindoo woman's life is exactly applicable to that of every woman one meets in the roads and fields. The fact is, there is no subject on which it is easier to speak to generalities from isolated facts, and it is so wide and complicated that one can hardly make a broad assertion without with perfect truth being contradicted as to the specific custom at any given spot. I merely say that the above description is, as fairly as I can make it, applicable to the life actually led by millions of Indian women, and it is the style of life toward which nearly all of them unconsciously gravitate.—*Journal of the Society of Arts.*

ALTRUISM ECONOMICALLY CONSIDERED.*

By CHARLES W. SMILEY.

THE primary motive of human action has always been the care of self, this being for man Nature's first and greatest law. In his unthinking zeal he has often followed this to a degree unnecessary, and consequently harmful to others. In his savage state, and especially in his primeval condition, where he was subject, like all the lower forms of life, to the law of the survival of the fittest, he could not consider others' interests because they were so antagonistic to his own. Often one of two must starve, and each would let it be the other one; he did not even become conscious that he was so acting for a very long period of time. It was the progress from a being not human to the being called man when sufficient intelligence had accumulated to make him conscious that he could live and let live. That point was also marked by and synchronous with the acquirement of such weapons and such skill as enabled man to procure food enough to make the starvation of some unnecessary. Then the war for the survival

* Vice-President's address before the Economic Section of the American Association for the Advancement of Science, delivered at the Cleveland meeting, August, 1888.

of the fittest, as known to biology, ceased among men. Ever since, so far as there has been a struggle affecting the survival of the fittest, and that struggle continues to the present day in certain ways, it has been of a different sort, and one which must not be confounded with the biologic law of the survival of the fittest. Major Powell has admirably shown how the strictly biologic struggle has ceased in man, but he has not yet shown, as may be, the character of that struggle, largely intellectual, which still works out certain survivals of the fittest.

Having passed from the point where, if he survive, it must be at the expense of others, man began to recognize and to consider the desires of his fellows, and among others he counted not only his fellows, but mythical and supernatural beings. Thus appeared the greatest natural basis of religion. It is not strange, therefore, that religion should have existed from very early times, and that it should have taught its votaries especially to regard the needs of others. Its mission was to teach a race whose ancestors had been absorbed for untold ages in caring only for self, to adapt itself to a new environment by learning to care for the wants of others. In caring for others, the more powerful soon received superior recognition, so it came to pass that supernatural demands took precedence of the rest. When that point had become clear, men were easily tempted to profess to represent the gods in order that they might share the precedence. In this natural way became established the order of duty which was taught by every religion prior to Christianity, viz.:

1. To the gods and their representatives. 2. To self. 3. To others.

Early Christianity must be credited with changing the order of duty to the following: 1. To its one supernatural being. 2. To all others equally with self.

Even under this improved system many people are led to make great personal sacrifices in the belief that thereby they are living the noblest life possible to man; when, in reality, as it is the object of this paper to show, their sacrifices are either useless, or, what is worse, grossly injurious both to themselves and to the supposed beneficiaries.

During all the untold years in which it was a physical necessity to regard self even to the injury of others, our ancestors acquired a predisposition thereto which heredity has brought down the stream of time. As being no longer a necessity, its practice long since became one of the recognized evils of the world. We apply to it the opprobrious epithet of selfishness. There is a better term, and one which does not imply a moral quality, for there may be devotion to one's own interests which should not be so characterized. Egoism is such devotion to one's own interests;

it may be proper and it may be improper. The term does not imply either propriety or impropriety. Let the word self-interest stand for justifiable egoism, and the word selfishness represent unjustifiable egoism.

Egoism, then, was once a necessity, and, while it was a condition to existence, it was justifiable, whatever its effects on others may have been. When things changed so as not to render egoism a necessity, man was still as prone to practice it as before. He was acting under the acquired impulses of ages. It was an extremely difficult thing for him to repress his egoism; it was perhaps even more difficult for him to understand that he ought to do so. And yet the change of circumstances had produced a change in its moral quality. From the practice of self-interest he had passed to the practice of selfishness, and he had so passed unconsciously, for the change was in environment and not in him. The same act that had been a virtue was now a vice. Of course, centuries were needed for this idea to develop and to be disseminated, but at length it came. Although the terms were not in use, the differentiation had taken place. The terms came when needed to express existing ideas.

Long after egoism had differentiated into self-interest and selfishness, came the idea of doing something for others. Man's powers were then so limited that this was not much. Even when he became capable he was slow to discover it and slower to act upon it. Heredity bound him. To loosen him was the mission of religion. Whatever its votaries may claim as to its history and purpose, the one great and overwhelming power that religion has had upon the world is this—it has developed doing for others. It has turned man's attention away from himself to those not himself. A most excellent term to use for this is *altruism*—a term first employed only about fifty years ago by Auguste Comte to signify devotion to others or to humanity. Percy Smith, in his "Glossary of Terms and Phrases," defines it as "the doing to another as one would be done by; opposed to egoism."

Such terms as benevolence and charity have been generally used to cover the idea of altruism, but in the mind of every one benevolence and charity involve the moral quality of goodness. It is of the greatest importance to have a word like altruism which does not imply any moral quality, and which covers all we do for others regardless of the consequences, just as egoism covers all we do for self regardless of consequences or of moral quality.

That mankind has thus far regarded all altruism as good is undeniably shown by the fact that neither the English nor any other language has words to distinguish proper from improper altruism. This distinction has not been well developed. It was early seen that the motives were of importance. If we do something for others, it should be with a good motive. The act was declared to be of no subjective value unless the motive was lofty, thus: "Do not your alms before men to be seen of them, otherwise you have no reward of your Father which is in heaven." Calling attention thus to motives was doubtless a great advance upon the preceding times. This improved form of altruism was, however, indiscriminate. Nothing was said or implied, in the above precept, as to the character of the persons to whom alms were to be given. Nothing was hinted or thought of the ultimate effect upon the recipient of giving alms, much less of taking steps to prevent any from needing alms. Elsewhere the intimation was that all who were poor should receive, as indicated by the direction "Go and sell all that thou hast, and give to the poor, and come and follow me, and thou shalt have treasure in heaven." "He that giveth to the poor lendeth to the Lord." "It is easier for a camel to go through the eye of a needle than for a rich man to enter into the kingdom of God." Here the extreme of altruism was proposed, but utterly without discrimination as to the objective effect.

Just as all people assume the moral character of benevolence and charity, so there is a disposition to assume that all altruism is good—in other words, to use it as a synonym. Some writers of much prominence have not properly treated the subject of altruism, and religious writers especially fail to measure its true character—that is, we see forms of altruism held up as the *summum bonum;* its teachings are said to be almost or quite divine. A professor in Johns Hopkins University has recently, in "The Congregationalist" spoken of altruism as the opposite of selfishness, which latter term he also confounds with egoism (and spells it "egotism"). This is very unfortunate. We shall never work out social problems with such confusion of ideas. Seeing men in such positions treat altruism as always a good thing, and seeing them urge its practice without consideration or without limitation, have prompted this attempt to distinguish between justifiable altruism and unjustifiable altruism as carefully as moralists distinguish between justifiable egoism (self-love or self-interest) and unjustifiable egoism (selfishness). And right here the moral philosophers must be alluded to. They have been so zealous to destroy selfishness that they have urged the doing of good to others without sufficiently distinguishing between seeming good and the evil effects thereof. They have too much determined the quality of acts by an examination of the motives under which the acts were performed, and too little by an examination of the effects produced. They ought long since to have studied the character of altruism.

For eighteen hundred years the world has had an altruism which failed to discriminate as to the object, and, as will appear later, altruism has often been carried to injurious excess, and yet we have had about as good general results as could be expected under the circumstances. The early step from justifiable egoism to that which discriminated was a long one. From the mind resting on self to considering the immediate wants of others was a great advance. From altruism performed with selfish motives to disinterested benevolence was another grand advance. The order of human progress doubtless required a long discipline in indiscriminate altruism before men should learn to differentiate it by observing its results. Again, not only man's mental progress but that of life on the earth has been by pendulum-beats from extreme to extreme, by action and reaction, until finally the golden mean of Horace has been reached. The shield was neither silver, as protested by him who viewed it from the east, nor yet gold, as viewed by him in the west; but, had not each held and proclaimed his opinion, the truth would not have been reached by either. Progress limps and goes by indirections; but the various steps indicated have been taken and well taken.

To Christianity, then, by far the greatest exponent of this indiscriminate altruism, is due the great credit of having taught it, and measurably brought the world from selfishness to disinterested benevolence. It matters not that the race might have traversed this path under some other banner, and that many tribes have found it independently. "Honor to whom honor" permits this willing recognition. Although it overlooked this newer feature, it had enough to do for man of a more primary character.

The most intense manifestation of the altruistic spirit is in non-resistance to evil and in utter disregard of self. How beautiful seem to us those precepts pointing thereto!

"Whosoever shall smite thee on thy right cheek, turn to him the other also. If any man sue thee at the law and take away thy coat, let him have thy cloak also. Lay not up for yourselves treasures upon earth, where moth and rust doth corrupt, and where thieves break through and steal. Take no thought for your life, what ye shall eat or what ye shall drink, nor yet for your body what ye shall put on. Consider the lilies of the field, how they grow; they toil not, neither do they spin, and yet I say unto you that Solomon in all his glory was not arrayed like one of these. Take therefore no thought for the morrow, for the morrow shall take thought for the things of itself. Give to him that asketh thee, and from him that would borrow of thee turn not thou away. Go and sell all that thou hast and give to the poor, and come and follow me, and thou shalt have treasure in heaven."

And yet however grandly its maxims may ring in our ears, whatever praises we may bestow upon its advocates, and whatever satisfaction we may express with the past, the day for this indiscriminate altruism has gone by, and we are confronted with present duty. To-day, the only man who sells all that he has and gives to the poor is the unfortunate one whom we shut up in the insane asylum. To-day, the only one who takes no thought for the morrow is the tramp or the beggar. (The professional beggar has even sense enough to keep a bank account.) Those extremes of altruism, non-resistance and self-abnegation, have been discarded. And why? Let us now recognize the virtue in them, and understand also just why they are impracticable.

The virtue of those precepts lies in their power to draw men away from self. Read them slowly—not a selfish motive to be found in them. They remove one the farthest possible from thought of self. At the time when the degradation of women was greatest, when chattel slavery was so universal that even Saint Paul returned a runaway to his master, when political freedom was unknown, when drunkenness and debauchery far exceeded the present, the best thing for mankind was to hold up this extreme of altruism as an ideal and even to declare it divine, which it nearly was in comparison with the evils combated. So long as no one could point out its defects, its force would be and was very great for good. Through the self-inflicted injuries which the early Christians caused in practicing these principles was the tide of human selfishness checked. But the evil of these precepts consisted in their subjective influence being excessive (therefore injurious), and in their utter disregard of ultimate and objective results. He who curbs his own selfish and grasping spirit by taking no thought for the morrow, lays himself liable to want (which is perhaps the lesser of the two subjective evils), but the objective effect is more far-reaching and only evil. It acts as an incentive to others to idleness, improvidence, and ultimate beggary. He who being smitten on one cheek turns the other, cultivates patience and self-control, but he leaves his assailant all the more ready to smite the next man he gets mad with. Again, the subjective effect has good in it; the objective effect has far-reaching evil in it. If I imitate the lilies of the field, which neither toil to make themselves a shelter nor spin themselves clothes, I may be admired for my assurance and freedom from anxiety, but I shall also be cut down by the first frost of adversity, and be ruthlessly swept out of sight by the first snow of winter. Objectively, I shall have set a bad example to weaker minds than mine. They will say, "Let us eat, drink, and be merry, for to-morrow we die." And the world will have paid dearly for my little exhibition of self-culture.

He who, being sued at law for a coat by a grasping neighbor, peaceably folds in a cloak also, may cultivate some useful feelings in his own breast while inflicting an unwise deprivation upon himself, but the victorious plaintiff has become a meaner man, and will bring new suits at the earliest opportunity; if not upon this, upon some other man whom he thinks he can browbeat, and there are plenty of lawyers who will help him do so. He who sells all he has and gives to the poor, may, if he is very badly eaten up with greed for money, discipline himself in the right direction, but in selling *all* he deprives himself of the means of self-support in sickness and endangers the care of his family. But all this subjective wrong might be perpetrated to curb a grasping spirit through the loss of property. That, however, which he had no right to do he has done. He has pauperized the poor. The evil inflicted upon scores, and perhaps hundreds, is in their lessening of self-respect, the cultivation of indolence, the enfeebling of their already weak determinations, the putting further away of that day when the poor shall be properly paid for their work, and the fostering of that reckless spirit, "The world owes me a living, and I am going to have it." If the next rich man does not sell out and distribute soon enough, they will thirst for his riches—perhaps for his blood. If some of his wealth is ill-gotten, as is the case with many rich men, they will consider it all so. In such soil the seeds of communism grow. The advocates of anarchy and the haters of government are found always among the poor.

Now note this most remarkable fact—that every single precept pointing to non-resistance and self-abnegation, while subjectively attractive, ignores the objective and ultimate effect; that is, they all seem to be of benefit to the doer, but make not an iota of discrimination as to the effect upon others; while, in fact, as history has shown, and as we are now beginning to know, both are injured; but the greatest harm is done to the supposed beneficiaries.

Self-abnegation is thus as far from virtue as selfishness. The golden mean lies between, where our egoism benefits us but does not sting another, and where our altruism benefits others in its ultimate effects without sapping their or our own welfare. Selfishness is short-sighted gratification of base impulses. Self-abnegation is short-sighted gratification of benevolent impulses. Both are impulsive, both are short-sighted, and both inflict evil upon others.

A more moderate and acceptable form of altruism goes under the names of charity and benevolence. They are also valuable in curbing the spirit of egoism, and have made many people, both givers and recipients, happy for the time being. "To do good and to distribute forget not, for with such offerings the Lord is well pleased." Again, no discrimination is made as to the objects of charity and of benevolence, nor as to the remote and real effects of such action. It seems to have been thus far assumed that no discrimination need be made. The exhortations to charity and benevolence never specify the objects minutely, while, in fact, this should be the all-important feature. In seeming prohibition to any suggestion of discrimination we are told that benevolence should be universal, because the Creator "maketh his sun to rise upon the evil and upon the good, and sendeth rain upon the just and upon the unjust." Now, in the case of sunshine and rain it would be physically impossible to discriminate. It should also be remembered that the same Creator for the same reason sendeth the lightning and the earthquake to destroy both the just and the unjust. But, what is more to the present purpose, he starves to death those who in summer fail to lay by a supply of food for the winter; he smites with disease those who are too lazy to cultivate cleanliness; and he visits the iniquities of fathers upon *thoughtless* children to the third and fourth generation. Here is a lesson in discrimination of cause and effect not to be overshadowed by a few platitudes about rain.

But we must turn to consider the economic effects of altruism by means of which we are to distinguish justifiable altruism from unjustifiable altruism. So much of description has been necessitated by the newness of the subject, and even now it is to be feared that those who have never discriminated as to doing good to others, except as regards the purity of motive in the doer, will feel more concerned about the integrity of the precepts that have been dissected than about the analysis of truth. Be that as it may—and it would be a matter of regret to offend the ancient prejudices of any—it is to be hoped that the economic remarks to follow will but substantiate and illustrate the principles already laid down.

Now that we have reached the study of social, political, and economic science, we are called upon to analyze the subject, to define our terms carefully, to be sure that we build our sciences on facts, and to state our conclusions clearly. And our conclusions are most hopeful. They are, that in doing real and not seeming good to ourselves we also benefit the race; that in doing good to others it is not necessary or wise that we inflict sore deprivation or indignity upon ourselves; that thrift and wisdom consist in taking a reasonable thought for the morrow; and that in nothing so much should we take anxious thought for the morrow as when appealed to for alms or to assist the needy.

Better that they suffer hunger to-day and be made self-respecting and self-supporting to-morrow, than that they be fed to-day and then be forgotten to-morrow. We best help others by securing them full justice, and by refraining from injuring them either through malice or through giving them that for which they return no equivalent.

I. Relief of the Poor.—This class does not include the sick, the dependent children, nor the insane, but simply those who are more or less of the time idle, who receive but small wages when they work, and who ask, or do not ask but seem to need, financial assistance.

So many have been willing to lend to the Lord (i. e., give to the poor), believing that it was a safe and dividend-paying investment, that for eighteen hundred years this has been the usual mode of relief.

Everybody knows that this has not diminished the number. It was very unfortunately said, eighteen hundred years ago, "The poor we have always with us," because the saying of it has helped to make it true. Assuming that we are to have the poor always with us, we shall do little to lessen their number. Had it been said upon the same authority, "Under the beneficent sway of wisdom the poor shall cease to exist among you," as it was said, "The wolf and the lamb shall lie down together," by this time we should have been far nearer the realization.

Early Athens—pagan Athens, if you choose—could boast of having no citizen in want, "nor," says the Grecian historian, "did any disgrace the nation by begging." This should have been our motto. With all the resources of this nation, its realization would have been easy had the proper course been pursued. In such a country as ours it is not necessary, but it is a shame and disgrace, to have the poor always with us—that is, poverty which needs relief. In the presence of millionaires, men owning but a single cottage are poor by comparison. We ought always to have such poor among us, but these are self-respecting and happy men. They must never be confounded with those who through defective character sometimes require food, coal, or shelter to be provided for them. The latter are intended when allusion is made to the poor.

Now, if anything of social and economic value has been demonstrated in this century it is that giving food, coal, and money to the poor from public funds or even by private charities pauperizes and degrades them. Henry George says that "the poor are growing poorer." If so, to nothing is it more attributable than to the multiplication of charities. "A city of charities and a city of paupers" is the designation of one of our Eastern municipalities.

How charity becomes the cause of pauperism may easily be understood. The problem has been well worked out, especially in England. Henry Fawcett, Professor of Political Economy in the University of Cambridge, in "Pauperism: its Causes and Remedies," published in 1871, says: "Those get the largest share of charity—not who suffer most, but—who can excite the greatest sympathy. Hence securing charity becomes an art; begging, a profession. Hypocrisy and lies are the principal tools. Those who acquire skill in it frequently obtain greater incomes than those who labor."

A case in Washington, D. C., illustrates this:* In August, 1885, a boy of about fourteen years was found regularly begging on Pennsylvania Avenue. His mother, healthy and reasonably intelligent, lived in a neat house on a pretty street within three blocks of the Capitol. There was no sign of poverty or of distress about the house, inside or out. The boy had, during the sessions of Congress, sold papers at the Capitol, reaping a rich harvest. He limped about with a crutch. People gave him five, ten, or twenty-five cents for a paper, and asked no change. When Congress adjourned, he could still have supported himself well by selling papers on Pennsylvania Avenue; but people there did not pay over five cents for papers, as a rule. Still, they did give to beggars, especially to those with crutches. It easily appeared that the boy could make more money by begging than by selling papers, and so he begged. Even after he had been taken into police court twice, he returned to the street to beg. It was only with great difficulty that the writer succeeded in stopping this imposition upon the public—the sweet, confiding public, which is ever seeking to give to strangers, because "some have thereby entertained angels unawares"—yes, a public which is too lazy to investigate the effects of its alms-giving, and which deserves to be imposed upon.

Now, let no one express horror at the character disclosed in this child, or rather in his mother, who was the real actor. She was no better and no worse than the average citizen. She simply exercised business sagacity in getting money apart from moral considerations. So do Wall-Street brokers; so do many men who endow colleges, build churches, and send missionaries to "the heathen."

The solution of this economic problem is of the simplest. Make begging unprofitable, and we never need lecture beggars about their loss of self-respect. When the getting of something for nothing becomes impossible, and never till then, will men cease to endeavor to get something for nothing. When you and every one of you completely discontinue giving alms, except to those whose circumstances are perfectly understood, self-respect and other moral qualities will develop in those people without even a word being said to them upon that point. In giving to them, *you* degrade society far more than they degrade it by asking. This kind of altruism is a curse in the world. Fawcett said of it, "England was brought nearer the brink of ruin by the old poor-

* I made the investigation of it in person, and prosecuted it in the police court before Judge W. B. Snell.

law than she ever was by a hostile army." Meanwhile we should be self-respecting enough to admit that tramps and beggars are not very different from many "respectable" people, after all.

Those who are interested to examine the economic results of giving to the poor, in England, Scotland, and Ireland, will find plenty of books on the subject. The "Encyclopædia Britannica" contains a good article under the heading "poor-law." See also other encyclopædias.

The Scotch are proverbially thrifty and economical, and yet they have been degraded by the poor-law of 1845. In some parts of Scotland there is ten times the poverty there is in Ireland! That law gives more relief than England's, and the money is regarded as a nice gift. Those who had savings in banks transferred them to others. Careful investigation, and even the labor test, did not quell the applications in any such manner as did the Irish workhouse. Matters came to such a pass that the fishermen of Wick could not get their nets mended, their former assistants saying that they could get a living easier from the parish.

In Ireland there is very little out-door relief, the proportion of Scotland being almost reversed—five in-door to one out-door pauper. In spite of Ireland's unjust land system and high rents, the whole number of her paupers does not amount to one half those of London alone. The Irish will submit to every privation rather than let friends go to the workhouse, which is the legal mode of relief, and is not a charity.

In London many people get relief who could do without it, and consider it no disgrace. Industry, economy, temperance, and self-restraint would enable most of them to take care of themselves if they would. Hence the workhouse is a necessary restraint, being uncomfortable or even disgraceful. They therefore shun it. If they may eat without work in some other way, they will; if not, many of them will work. Why are these people in such condition? It is a duty we owe to society to ascertain what are their thoughts, what the motives that have led them to such lives. If the result is that the vices and injustices and prodigality of the rich have in part induced such results, let it be exposed boldly and fearlessly. If injustice in the wage system and in land tenure is the cause in part, let this also be proclaimed.

You will, however, be more interested in some figures from our own experience. The Hon. Seth Low, ex-Mayor of Brooklyn N.Y., presented a paper in 1881 at the eighth National Conference of Charities and Corrections in Boston which Robert Treat Paine calls the corner-stone of relief reform. In it Mr. Low sums up his opinion of the world's experience in giving alms (technically called out-door relief). Of the supposed beneficiaries he says:

1. That it saps their habits of industry.

2. That it discourages habits of frugality.
3. That it encourages improvident and wretched marriages.
4. That it produces discontent.

His own conclusion as to what he had himself seen was that "out-door relief in the United States as elsewhere tends inevitably and surely to increase pauperism." Here are some of his statistics:

In Brooklyn, during 1877, 46,350 people were relieved at a cost of $141,207. In 1878 no money was given. This immense number of people which had received aid were left to take care of themselves, or to go to almshouse or to hospital. What effect on these institutions did refusing to give to 46,350 people have? In 1877 and 1878 these institutions contained 1,371 people; in 1879, 1,389 people; in 1880, 1,199, and in 1881 only 1,171. What became of the people that had received the $141,207, in a single year? Mr. Seth Low says: "Instead of Brooklyn needing, as the result of the abolition of out-door relief, an almshouse of mammoth proportions, we find at the end of three years an almost imperceptible increase of sick paupers, but a steady diminution of well paupers; and this, too, in the face of a population in the county growing at the rate of 18,000 per annum." At about the same time similar action was taken in Philadelphia, with like results. Cleveland's out-door relief account for six years was as follows:

1875 to 4,590	families	$95,000.	1878 to 1,568	families	$32,300.
1876 to 3,094	"	85,000.	1879 to 1,550	"	22,600.
1877 to 2,386	"	70,000.	1880 to 1,200	"	17,000.

In March, 1877, was begun a system of requiring an equivalent for the relief furnished. Work at one dollar per day was provided every man who being able-bodied applied for assistance. The officials were thoroughly convinced that pauperism had been fostered and increased by the old system.

Cincinnati pursued the same course, with good results, except that it issued during ten winter weeks coal by the bushel; but even that was improvident and demoralizing. People who know that a city issued coal last winter will count on getting it this winter, and will take no other thought on the subject.

Now we know, by experiment, that the wise thing to do is to visit all such people in July and August, and induce them to lay by a few cents a week for winter's coal, promising it to them at lower prices. If, thus reminded to provide for winter, they are less sensible than the squirrel, they must in all fairness to themselves be allowed to suffer discomfiture in winter and be taught by bitter experience. He who gives to the poor under such circumstances may be very benevolent at heart, but his influence is worse than that of a miser who refrains from giving.

What, then, must we do? Fortunately, our altruistic feelings may be gratified in a manner not harmful to the beneficiaries. Robert Treat Paine, of Boston, who has had large experience in treating the poor, prescribes the following: "Whenever any family has fallen so low as to need relief, send to them at least one friend—a patient, true, sympathizing, firm friend—to do for them all that a friend can do to discover and remove the causes of their dependence, and to help them up into independent self-support and self-respect." To which it may be added, if that friendly visitor is permitted to give alms, his and their minds are diverted from the great object—the permanent cure of poverty. It should always be regretted when circumstances seem to demand attention to immediate needs. Put off every possible want till the person can himself supply it in a manly and independent way. Better a morsel with self-respect than plenty with an enfeebled determination to fight the battle of life.

II. Orphan Asylums.—Much that has been said of giving alms applies to the treatment of delinquent and dependent children. Moved by the altruistic spirit, and feeling an approving conscience as the result of trying to do good to others, the Christian world has taken up the care of orphan asylums. Children are gathered from the slums of cities, and sometimes from pretty good homes, in to these herding-places. Then they are told, as I heard from a reverend doctor, how grateful they should be to Christianity for thus caring for them; but the fact again is that, prompted by kind motives, people thus try to do these children good without looking to the results of their acts to see the consequences.

What, then, are some of these consequences?

1. That moral corruption, brought in a little by each child, leavens the whole lump.

2. That they are often placed under incompetent teachers to learn book-lessons, when in fact their capacities call for manual training instead. (Who ever knew a scholar reared in an orphan asylum?)

3. They are fed in the cheapest sort of a way, and clothed in a uniform that causes them to be pointed out always in public as objects of charity and degradation.

4. They are kept in herds and not in families, and hence subject to rules and training necessitated by this abnormal life. Often they are so unfit to live in families that kind-hearted people can not adopt them.

5. Every delinquent mother and every drunken father now knows that he and she can indulge their vices and get rid of their children. Thousands of widowed mothers, learning that they can marry again if not encumbered with children, are putting their little ones in asylums. The asylum thus offers a premium to child-

desertion. Rich people even are living in luxury, while their nephews, nieces, and grandchildren are being corrupted in orphan asylums! The niece of a President of the United States was, not long ago, in an asylum, while her uncle, aunt, and three cousins, occupied the White House! Such people often give as their excuse that the child was too vicious, or rude, or even homely, to be received into their families. "No one seemed to want him."

Better the humble home of a poor farmer in the West, far better for such children as are unavoidably orphaned, than these unnatural corrals. But this kind of orphans constitutes not over one fifth of all. The other four fifths represent indulgence, by the asylum founders and managers, toward parents and relatives who wish to shirk responsibilities imposed by Nature upon them. With every such indulgence issues moral miasma upon society, which festers and reproduces its kind. And all this time people with good motives and benevolent spirits thank God that they are not as other men are, and proceed to build additional asylums! Better and far better live and die among the Zuñi Indians of New Mexico, having never heard of Christian charity, than to die and leave your orphan child alone in a large city of the United States! In the latter case he goes to an asylum, to be swallowed up in the masses. In the former case, although he has lost his own father and mother, he has found many fathers and many mothers, all of whom will feel a personal interest in him and responsibility for him, and who will share with him if need be the last pot of corn, and will weep over his grave as if it contained their own flesh and blood. We should need no orphan asylums if we possessed the virtues of the Zuñi.

How to set forth the economic effects of such institutions, and to point out to society the way to make its members rear the children to whom they have given birth, and to show the disastrous effects of ill-considered altruism, is a task which comes within the province of this section of the American Association for the Advancement of Science.

III. Foundling Asylums.—Here, again, sentimentalism has contributed money to build asylums, and even more unwisely than in the case of the orphans. An orphan can not be committed without something being known of its parents, or their circumstances, and without formal papers of transfer. This routine exposes many frauds, and leads managers to reject thousands of applicants for admission. Managers like to boast of the cases they have rejected. With foundlings, nothing of the sort occurs. The girl whose yieldings to temptation have made her a mother, be she in high life or in low, the intemperate who prefer to use their means for drink to rearing their own offspring, the society people who have boasted that there will be no children in their families—one and all—have but to leave their offspring as naked as little Moses was when deposited at the Nile, either in a vacant lot or upon some handy door-step. Under cover of darkness all is secret. Either a policeman, or the irate citizen whose door-step has been invaded, quickly and safely transfers the waif to an asylum. The reminders of sin and folly, as well as the burdens of the parents, have thus been put far away. Were society organized to encourage this very business, it were impossible to arrange it more satisfactorily. But eternal shame should rest upon the weak-minded, benevolent people who by their ill-advised altruism cultivate such degradation in society! One tenth of the money spent in detecting and punishing these parents for their unnatural crimes would teach society the needed lesson. More pains than we take to catch a murderer should be spent upon detecting these criminals. Every foundling asylum in America should be instantly disorganized.

IV. Insane Asylums.—Upon this kind of altruistic effort, also a boast of the age, there are not sufficient data to warrant so severe denunciation. It is proper, however, to call attention to some suspicious circumstances:

1. The collecting and imprisoning of great masses of such people is unnatural, and the best authorities advocate breaking up the system by substituting homes and separate buildings.

2. To the non-medical observer it is surprising that, while rapid progress is being made in treating many forms of disease such as are caused by minute germs, so little knowledge is being obtained concerning the nature, causes, and cure of insanity. With many physicians, supported by the state in a liberal manner, why are they not bringing forth fruit in this direction? It is said to be because incapable men get places through intrigues, and because so much time is spent in routine work.

3. The number of the insane is on the increase. Some of the immediate causes are understood. Is it not certainly of the utmost importance that facts bearing on these points be circulated, and that great effort be made to check insanity by rooting out of society the immediate and ultimate causes?

The altruistic work suggested by these questions can have no unjustifiable effects. That which has been performed is more questionable, as implied by the changes proposed, and upon further examination may prove more unjustifiable. In any event it is plain that doing good to those now insane may not be of half the importance that it is to find means of preventing insanity in the future.

V. Benevolence in Higher Education.—It used to be a practice to give not only tuition, but even board and clothes, to young men studying theology. It was considered that they were preparing to lead lives devoted to altruistic work, and that it was therefore desirable, in the case of young men apparently without means, to pay their expenses in theological schools, but it worked so badly that the plan is undergoing change. In the best schools where funds are provided, they are now loaned, and a written obligation to repay is executed. In other words, the managers of schools of divinity found out that to give to the poor theological student was to lend to the devil—a very different creditor from the one they had in mind! It was found that this money got used at times for tobacco, for pleasure-trips, etc., while board-bills were unpaid, and that after it was spent the beneficiaries sometimes abandoned the life-work they had contemplated.* But even the loan system is not working satisfactorily. The written obligation is often lightly esteemed, and held to be not binding. The writer's latest information is that but thirty per cent is paid back. Only when the notes are looked after, as a successful banker looks after his paper, will the system become truly beneficent. It will then have ceased to be a charity. Again let it be said, *do not give something for nothing*, but, if you really must do so, then put it into a lottery.

VI. Gifts to Workingmen.—There is reserved for the last a notice of the most contemptible form of altruism now known to civilization. It has come to be the fashion for people who have acquired money without giving an equivalent in labor and who wish to indulge in benevolence, to build mission-chapels in outskirts of cities, and to furnish them with cheap appliances in order to "save the souls" of the dear working-classes. Another form this takes is in furnishing workingmen libraries and reading-rooms, and even in building improved tenement-houses. In a score of ways the rich are "doing something for the poor." Now, all these things have the same surface appearance of charity as throwing a dime to a beggar. But the fact is, that these people have by class legislation or dishonesty got possession of wealth created by the poor, and in order to quiet their little consciences, or occasionally in order to enable them to keep up the fraud, they dispense these charities.

Now, let it be reported to all such that the workingmen need none of their charities. They cry out for justice, for fair wages for a day's work, for reasonable rents, for a chance to buy house-lots which speculators have not pushed beyond honest men's reach—in short, for such a reorganization of legislation and custom as will enable them to labor and to administer upon the entire fruits of their labor, to build and furnish their own chapels if they

* There has been in government employ in Washington, the past eight years, a young man who received such aid for two years previously. He now owns real estate in Washington, but he never preaches.

choose, to establish their own libraries and reading-rooms, to build their own tenement-houses, and to scorn charity as they now have good reason to scorn such dispensers of charity.

The basing of all so-called charitable and benevolent work upon such principles as have been indicated, or rather the substitution of right-seeking and right-doing (which is but the simple practice of justice), will require earnest study and a great change in our spirit and methods. Those who in preceding years have here listened to outlines of work adapted for this section as presented by Professor Elliott and Major Alvord should notice that the bounds will be much enlarged if we seek to solve the problems which shall enable us to make our altruism economically beneficial. This certainly should be the case. That we should pretend to be doing good to all men, and yet be deceiving both ourselves and them, while really doing harm to both, needs only to be demonstrated to secure our condemnation. And giving alms to show even to ourselves our good motives, or in order to indulge our benevolent impulses, is certainly the most deceitful form of selfishness, since it appears in the form of altruism—is evil and only evil.

THE PROBLEM OF A FLYING-MACHINE.

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IN "The Popular Science Monthly" for November, 1885 (vol. xxviii, p. 1), Mr. Mather closes an excellent article on flying-machines with the following weighty remark: "These are the most important inventions of this class—i. e., self-raising, self-propelling machines. It must be confessed that the results are far from encouraging. *But, there are the birds; and they completely refute the argument of those who say that it is impossible to make a flying-machine.*"

Now, I wish to take issue with Mr. Mather in this conclusion. I am one of those who think that a flying-machine, in the sense indicated above—i. e., self-raising, self-propelling—is impossible, in spite of the testimony of the birds. Of course, it is understood that I am speaking of *true flight*, like that of a bird or an insect, and not of *ballooning* nor any combination of ballooning with flying. This is sufficiently implied in the words "self-raising and self-propelling." I wish now to give, very briefly, a reason for my faith. I can best do so with brevity and clearness by a series of propositions which I hope will lead us, step by step, to absolute demonstration. I believe this is important, in order to check baseless expectations and limit effort to the right direction.

1. Two Kinds of Impossibles.—On the very threshold of my subject I am met by the objection that "many things far more wonderful, and, before their realization, seemingly far more impossible, than flying-machines, have, nevertheless, actually come to pass. Then why not this also? He is a bold man that declares anything impossible in this age of rapid progress and startling inventions." I answer: True enough, many wonderful and apparently impossible things have indeed come to pass; and that, too, in spite of the adverse predictions of some rash scientists. But there are two kinds of impossibles—the *seeming* and the *real*. The *seeming* impossibles we *believe* to be impossible, only because we do not yet understand the principles involved in the problem, and therefore can not conceive the conditions necessary for their successful application. Such are all the cases which most readily occur to the mind as triumphs of science—such, for example, as the locomotive, the telegraph, the telephone, etc. The *real* impossibles, on the contrary, we *know* to be such, because we see clearly through all the principles involved in the problem and the *limits* of their possible application. Of this kind are the *problem of a perpetual-motion machine, and of a self-supporting arch of indefinite length.* Now observe—that, of these two kinds of impossibles, to the unreflecting the *seeming* are far the more impossible and wonderful. In fact, to most people the *real* impossibles do not seem impossible, or wonderful, or even difficult at all. Hence, in every age and country we find men who waste their lives in vain attempts to make perpetual-motion machines. So, also, in regard to the indefinite arch. Most people do not see at once why an arch of any length should not support itself if only it be big and strong in proportion to its length.

Let me stop a moment to illustrate this by an anecdote. I remember many years ago meeting a traveling agent of a Remington bridge (a wooden suspension-bridge), who had with him for exhibition a small model which, when set up, was about twenty feet long, and had stringers about as big as my finger. This little model not only sustained itself, but, in addition, the weight of a stout looker-on—"a fat and greasy citizen"—twenty times as heavy as the bridge itself. "Now," said the plausible agent, "if you increase the size and strength of the stringers in proportion as you increase the length of your bridge, it is evident that a bridge of this pattern, of *any length,* will not only sustain itself, but twenty times its own weight in the form of loaded wagons." Most of those who heard it accepted his reasoning as irrefutable. Of course, every engineer knows that this is not true. For, while the *weight* of the bridge increases as the *cube* of the diameter of all its parts, the *strength* of the stringers increases only as the *square* of their diameter. In increasing the size in all dimensions, therefore, the weight will quickly overtake the strength. There is a *limit*, therefore, beyond which it is impossible to make an arch or suspension-bridge support itself. This fact is so well recognized that it is unnecessary to dwell upon it. I have brought it forward at all only because I wish to apply the principle to other cases where it is not so well recognized.

2. Application to Walking.—Now, this principle applies not only to bridges and arches, but to all kinds of structures, and therefore, also, to locomotive-machines, whether natural or artificial. For example, there is a limit of size beyond which it is impossible to make a successful walking-machine, and beyond which, therefore, a walking animal can not exist. Beyond that limit the supporting bones would crush beneath the weight of the animal. It is in vain to say that we will make the bones and muscles thick and strong in proportion to the increasing size of the animal; for, as the animal increases in size, its *weight* increases as its volume or as the cube, while the strength of bones and muscles increases only as the cross-section or as the square of the diameter. Therefore, as the animal increases in size, a larger and longer portion of the whole strength is consumed in the support, and less and less is left over for motion, until, finally, the weight overtakes the utmost strength of bones to support or muscles to move. It is probable that the limit of an efficient walking-machine has actually been reached in the largest animals which have walked the earth; such, for example, as the huge dinosaurs of the Jurassic period, recently brought to light by the researches of Marsh and Cope. The whale has probably passed the limit, and therefore was compelled to change its form and take to the water, and become a swimming-machine. Or, to speak more definitely and also more truly, the whale family in times long ago, perhaps in earliest Tertiary times, before it became a true whale family, found it profitable, either for food or for safety, to take to the water; and this not only determined a change of form, but also allowed it to attain a greater size than was compatible with walking.

This principle explains many other things in nature which would otherwise be inexplicable. The marvelous vivacity and energy of insect-motion—the arrowy swiftness of flight of many kinds of flies, the prodigious leaps of fleas, the immense weights dragged by ants—are familiar to all. In text-books on natural history these are given as examples of the almost inconceivable nervous and muscular energy of insects, as compared with vertebrates. It is often said that if *our* nerve- and muscle-energy were as great as that of a flea, we might easily leap a quarter of a mile. In that case we would have little use for railroads or for seven-league boots, or indeed for flying-machines. Now, this is an entire misconception. There is no reason to believe that *our* muscular energy is any whit less than that of insects—that, taking a bundle of muscular fibers of equal cross-section, the contractile power is any less in *our* case than in theirs. The explanation is easily found in the principle above stated. These apparently wonderful feats of insects are simply the result of their small size. Weight *de*creases as well as *in*creases as the volume, i. e., as the *cube*, while strength of muscle only as the cross-section, i. e., as the *square* of the diameter. Therefore, with decreasing size weight decreases far more rapidly than strength, and therefore the ratio of strength to size *in*creases; and therefore, finally, less and less energy is consumed in support, and more and more is left over for motion. If any one desires to pursue this subject further, he will find it fully treated in a previous number (April, 1883) of "The Popular Science Monthly," in an article by Delbœuf on "Dwarfs and Giants."

3. Application to Natural Flying.—Now, this same principle of limit applies with greatly increased force to flying. There is a limit of size and weight of a flying animal; and on account of the prodigious energy required for aërial locomotion *that limit is very low, not much more than fifty pounds, certainly much less than one hundred pounds*. The largest flying-birds, such as the bustard, the turkey-cock, and the condor, rise with difficulty. They are evidently near the limit. There are, indeed, birds which are much larger, such as the ostrich, the emu, and especially the extinct *Dinornis* and *Epiornis*, but these are all flightless. They do not fly, not because their wings are aborted, but, on the contrary, their wings became aborted because they did not fly, and they did not fly because they had grown too large. Nature could not make them fliers, and therefore did not try. Or rather, it might perhaps be said, she tried her best and failed. Their wings became aborted because their size had passed the limit of possibility of flight. I imagine that the history of their evolution was briefly something as follows: They sprang originally from large birds of heavy flight; but being somewhat isolated from severe competition, on islands with abundant food, natural selection took the direction of *size* and *strength* for victory in contest, rather than *swiftness* of flight for escape from danger. They quickly passed the limit of size for flight, and their wings becoming useless were aborted.

4. Relation of Rising to Propulsion in Flight.—There is another principle involved in flight which must now be stated. There are two things to be considered, viz., *rising* and *propulsion*. We have already shown that the ratio of weight to strength, and therefore the *difficulty of rising*, *in*creases as the size or weight. We now add that the resistance of the air to motion through it,

and therefore the *difficulty of propulsion* of a flying animal, *decreases* in the same ratio. The one varies *directly*, the other *inversely*, as the size.

This is a principle of very wide application, and I stop to illustrate it by many familiar phenomena. The floating of dust and smoke, the suspension of clouds, the slow settling of fine sediments, are examples. As the particles become smaller, the resistance of the air or water to falling through it, decreasing as the surface, i. e., as the square of the diameter of the particle (d^2), while the force of motion or weight decreases as the volume, i. e., as the cube (d^3) of the diameter—evidently the force decreases much faster than the resistance, and therefore the ratio of force to resistance, or the *effective force* of motion, becomes less and less, until in very small particles it is a vanishing quantity. For this reason it matters not how great the specific gravity of a substance may be, if the particles are only small enough they will float indefinitely in air or in water. Particles of gold may be made so small by precipitation from solution that they will require months to settle. Krakatoa-dust (if that be the true cause of the after-glow and of Bishop's ring) remained suspended in the air for more than two years. The perennial blue of the sky and of mountain-lake water is due to suspended particles.

Now, this principle applies not only to resistance of the air to the *force of gravity* in *falling bodies*, but also to resistance of the air to the *force of propulsion* in *flying bodies*. As a flying animal becomes smaller (as in the smaller birds and in insects), a larger and larger proportion of the whole flight-energy is consumed in *propulsion*, and a less and less proportion is necessary for *rising*. On the other hand, as a bird becomes larger, a progressively larger portion of the whole flight-energy is necessary for *rising*, and less and less is necessary for propulsion, until finally at the limit the whole is necessary for rising. Beyond this, of course, flight is impossible. This explains why large birds like the condor rise with difficulty; but once up they sail with ease and grace,* while small birds and insects rise with ease, but require rapid and incessant fluttering in progressing.

5. Application to a Flying-Machine.—Many readers who have followed me thus far with entire assent will probably object right here that, while all this may be true of *flying animals*, it may not be true at least to the same extent—i. e., the limit may

* Marey has lately ("Nature," vol. xxxvii, p. 369, 1888) shown that there is still another reason for the greater ease of flight after the bird is well on its way. In starting, the wing, except at the very beginning of the stroke, pushes against air which is already in motion in the same direction as the wing itself; but in swift flight *the whole stroke is against dead air*, for the air beneath the wing is continually renewed by the motion of the bird.

not be so low—in *flying-machines.* There are forces, they will say, such as steam, electricity, explosions, etc., which are far more powerful than muscular contraction. Especially is electricity looked to in a vague way to do for us many wonderful things, this of flying among the number. Now, this is again a great mistake. Nerve-energy acting through muscular contraction, and supplied by the combustion of foods, such as oils, fats, starch, sugar and fibrin, together form the most perfect and efficient engine that we know anything of; i. e., *will do more work with the same weight of machinery and fuel.*

There was much loose talk a few years ago about condensing and storing electricity in immense quantity, in small space, by the use of Faure's battery. Millions of foot-pounds, it was said, may be thus condensed and stored in a small box and carried about. To the unreflecting, millions of foot-pounds seems a very large quantity. Extravagant expectations were thus raised in the popular mind. I remember at that time talking with a very intelligent gentleman on this very subject of flying-machines; and he, in rebuttal of my argument, suggested the use of stored electricity. "Why," said I, "there is more energy stored in a piece of coal that may be put in the vest-pocket than can be stored in a Faure's battery weighing three hundred pounds!" Faure's battery is doubtless a good thing, but chiefly, like a fly-wheel, not for increasing the *amount* but regulating the *flow* of force. He then suggested the enormous force of explosives, such as the nitro-compounds. The feeding of these to the engine might, he rightly thought, be so regulated as to supply a continuous force. But here also lurks a fallacy, the result again of a misconception. The force of such compounds is characterized by great *intensity* rather than great *quantity.* The whole force is compressed into an almost infinitely small space of time, and therefore very intense. But stretch it out as a continuous force and it becomes no greater, probably less, than that of an equal weight of burning coal. There is probably no greater available energy in the world than that produced by the burning of carbon and hydrogen. It is this form of energy that we use in steam-engines; this we find most powerful and economical in making electricity; this, also, is what is used in the animal machine. The only question that remains, then, is the *relative economy of its use.* Now, I think it will be admitted on all hands that no known engine compares in this respect with the animal body. It is acknowledged by mechanical engineers that the animal machine, burning hydrocarbonaceous food, and acting through nerve and muscle, more nearly approaches the theoretical limit of possible work than any, even the best, steam-engines. More accurately, the animal body is about twice as effective as the best Cornish engine.

The reason of this wonderful effectiveness of the animal machine is obvious. See how this machine has been gradually perfected throughout infinite ages, especially in birds. During the whole geological history of the earth this machine has been steadily improving in structure of skeleton, energy of muscle, and rapidity of combustion of fuel, by struggle for life and survival of only the swiftest, the most energetic, and the hottest-blooded, until an almost incredible intensity is reached in birds. Moreover, in them everything is sacrificed to the supreme necessity of flight. Viscera, skeleton, legs, head, all are made as small and light as possible to make room for the great pectoral muscles working the wings. Add to this the exquisite structure of the wings and feathers, adapting them for the greatest effectiveness; and we must admit that a bird is an incomparable model of a flying-machine. No machine that we may hope to devise, for the same weight of *machine, fuel,* and *directing brain,* is half so effective. And yet, this machine thus perfected through infinite ages by a ruthless process of natural selection, reaches its limit of weight at about fifty pounds! I said, "weight of machine, fuel, and *directing brain.*" Here is another prodigious advantage of the natural over the artificial machine. The flying animal is its own engineer, the flying-machine must *carry* its engineer. The directing engineer in the former (the brain) is perhaps an ounce, in the latter it is *one hundred and fifty pounds.* The limit of the flying animal is fifty pounds. The smallest possible weight of a flying-machine, with its necessary fuel and engineer, even without freight or passengers, could not be less than three or four hundred pounds.

Now, to complete the argument, put these three indisputable facts together: 1. There is a low limit of weight, certainly not much beyond fifty pounds, beyond which it is impossible for an animal to fly. Nature has reached this limit, and with her utmost effort has failed to pass it. 2. The animal machine is far more effective than any we may hope to make; therefore the limit of the weight of a successful flying-machine can not be more than fifty pounds. 3. The weight of any machine constructed for flying, including fuel and engineer, can not be less than three or four hundred pounds. Is it not demonstrated that *a true flying-machine, self-raising, self-sustaining, self-propelling, is physically impossible?*

6. Application to a Swimming-Machine.—But is there not a way of escape from the toils of this inexorable logic? We have said the limit of the weight of a flying animal is about fifty pounds. The limit for a walking animal is much higher, probably several tons. For a swimming animal there is *no limit of weight and size,* because the water sustains the weight, and therefore the

whole energy may be used in propulsion alone. Now some may think they see in this a solution of the problem. They will say, "Why not sustain the machine by gas, so that the whole energy may be expended in propulsion alone?" I answer, that in proportion as the balloon principle is added to the flying principle, in the same proportion is *size increased without corresponding increase in power;* and therefore in the same proportion is increased the resistance of the air to propulsion, and, what is worse, in the same proportion is our machine at the mercy of winds. But it will be objected: "See the fishes, how they swim! *They* are not at the mercy of currents. They float suspended in the water—they dart forward against currents—they ascend cascades and leap waterfalls; in a word, they are largely independent of water-currents. Now suppose we make a machine exactly the shape of a fish, tail and all; then, by the addition of gas, make it the same specific gravity as the air; then, by machinery, make it wiggle its tail in the manner of a fish. Where is the difference? Why may we not make an aërial swimming-machine, if not a true flying-machine?" Doubtless it is in this direction that we must seek the partial solution of the problem, not indeed of flying, but of *aërial navigation.* Yet the answer to the extravagant expectations expressed above is plain. The fish—its bones, muscles, viscera, brain—the materials out of which are made machine, fuel, and engineer, are of the same specific gravity as the medium (water) in which it swims. Now, whenever we can find materials out of which to make our machine, fuel, and engineer, which shall have the same specific gravity as the air, then, indeed, we may make a successful swimming-machine which shall be independent of winds. But so long as our materials are six or seven hundred times (wood), or five or six thousand times (iron), as heavy as air, we shall not succeed, because of the enormous dead space filled with gas that we are compelled to use, which adds to the resistance of the air and the power of the winds, without adding anything to the power of propulsion.

Therefore, we repeat, a pure flying-machine is impossible. All that we can expect—all that true scientists do expect—is, by skillful combination of the balloon principle with the true flying principle, to make *aërial navigation* possible in moderately favorable weather—in other words, to make a *locomotive balloon*; or, if we choose so to call it, an *aërial swimming-machine.* That something really useful of this kind will eventually be made, there can be no reasonable doubt.

SUN-POWER AND GROWTH.

By JULIUS STINDE.

WE know that our planet retains the position which it occupies in the solar system through the force of gravitation: we know, furthermore, that all organic life on our earth depends upon the warmth and the light which it receives from the sun: but of the intimate relation which exists between organic life and the changes taking place on the sun we are in comparative ignorance, notwithstanding investigation has brought to light a number of important facts.

That the growth of plants in our zone stands in intimate relation to a rise in the temperature of the earth is well known; but the fact that a force varying in intensity and influencing the growth of the human organism proceeds from the sun is a discovery as novel as it is interesting. Some phenomena, possibly referable to a property of this kind, were observed during an experimental investigation of the diet furnished to the inmates of the Royal Deaf-Mute Asylum at Copenhagen.

When, some years ago, a change of diet was proposed for the inmates of this institution, the director, the Rev. R. Malling-Hansen, thought it desirable to obtain a clear idea of and some definite data concerning the thriving of the children under the system then practiced, by which the results and the value of the new system of nourishment proposed could later on be accurately determined. The conscientiousness of the superintendent and pastor of the asylum would not permit the permanent substitution of a new system of diet without first possessing some facts by which its advantages or disadvantages would be plainly pointed out.

For this purpose the children were daily weighed and measured in groups, in which manner the total weight of the pupils was quickly and accurately ascertained. The technical details as well as full statistics on the subject will be found in Rev. Malling-Hansen's work, "Periodicity in the Weight of Children and in the Heat of the Sun" (Copenhagen, V. Trydes). These weighings present some very interesting facts.

Until then it had been supposed that the growth of a number of children (of different ages) averaged the same throughout the year, and that the increase in weight as well as in height of a greater number of children might be registered by a straight line slanting upward. The annotations of the weighings and measurements of the Royal Deaf-Mute Asylum at Copenhagen proved, however, that the universally accepted biological theorem is wrong, for the weight-lines of about seventy children had no even gradation but showed great changes during the year. During each of the three years the greatest increase in weight took place in the fall until the beginning of winter, then till the end of April the increase grew less, and after this time a loss in weight was noticed. At times the increase in weight of the children would cease suddenly for a few days, and occasionally during the time when an increase was expected a general decrease occurred. Based upon his measurements and annotations, Malling-Hansen framed the following rule: The weight of a boy ranging from the age of nine to fifteen undergoes three periods annually—a maximum, a medium, and a minimum period. The maximum period lasts four and a half months, commencing in August and ending the middle of December; the medium stage has the same duration, from the middle of December to the end of April. The minimum period appears during the remaining three months, from the end of April to the end of July. The increase in weight during the maximum period is three times that of the medium period, and almost all the gain of the medium period is again lost during the minimum period. From the working of this law it follows that in changing the diet at academies, schools, and asylums, the season should be considered. A good diet would give less satisfactory results if observed from April to June, than a poorer diet if noted from August until December.

In the same manner as the *increase* in *weight*, the *increase* of *growth* fluctuates, and can likewise be divided into three periods. These periods commence and close about a fortnight before the periods of weight, but in such a manner that the minimum period of growth occurs at the time when the weight remains stationary, and may at times even be coincident with important loss in weight. Growth takes place, one might say, at the expense of the increase of weight. Accurate observation showed that the general growth of the trees in the garden of the institution corresponded essentially with the growth of the children. The maximum period of growth upward is followed by that of increase in circumference. The growth of the human body and the growth of the trees are consequently influenced in the same manner by some disposing cause. But what is this cause?

As the fluctuations referred to above coincided strikingly with the fluctuations of atmospheric warmth, Malling-Hansen believed that they could be attributed to local meteorological conditions; and it was really shown that with a rise of temperature the weight increased, and *vice versa*. It was, however, ascertained that during the minimum period a rapid rise of temperature but slightly affected the increase in weight, and in the same way the decrease in temperature during the maximum period influenced the weight but little.

Furthermore, it seemed remarkable that the children should lose in weight instead of gaining, with the progressive rise in temperature in spring and in early summer, and that in fall the opposite relation should obtain. If heat alone were the active medium, the warmth indoors in winter would exert some influence; this was, however, not the case. Many other observations indicated that local changes of temperature were not the looked-for cause, as the fluctuations in weight of the inmates of the Royal Asylum corresponded to those of the deaf-mute children, notwithstanding the great difference in the location and surroundings of these two institutions. The force, moreover, seemed not to be influenced by the seasons, but to continue invariable during frost and heat, during sunshine and rain; its action on the whole was not affected by the warmth of indoors or by the cold without.

The fluctuations of the increase in weight were more regular than those of temperature; these fluctuations, with their great variations and their periodicity, seemed to show that organic growth, of both human beings and animals, is affected by some to us as yet unknown cause. This influence is partly mirrored in the local fluctuations of temperature, and these again, of course, are in connection with the sun.

If the inference should prove correct that increase and decrease in weight vary with the solar radiation, the thermometric registration of places on the Continent, not exposed to sea-winds, would coincide more accurately with the results of the weighings than the local climatic condition of Copenhagen would render possible.

Mr Malling-Hansen undertook the task of tracing in curves the fluctuations in temperature of different meteorological stations recorded in the Danish Institute of Meteorology. The stations, which are at the following places, permit a broad view, as they are at great distances from one another: Copenhagen, Vienna, San Fernando, Lucknow, Tragpoor (India), Paramaribo (Guiana), Cordova (Argentine Republic), Port Dover (Canada), and Vioi (on the Congo).

The more these curves were compared with one another, the more did they show a remarkable analogy between the fluctuations of temperature over the whole globe, and the fluctuations in the weight of the children at Copenhagen. And, furthermore, the curious fact was discovered that the fluctuations in temperature in India, as well as in Copenhagen and in North and South America, varied in a similar manner, and were analogous to the fluctuations shown in the weight-increase of the children in accordance with the variations of temperature experienced at the different places. All these fluctuations in the weight of the children picture the result of an influence emanating from the sun.

All the growth on the globe, from the most minute to the largest being, from the simplest to the most perfect organism, with all its variations and fluctuations, stands in close relation to the sum-total of heat of the earth's atmosphere.

As, however, the warmth of the sun is influenced differently at different places by clouds, by wind, and by dampness, it never reaches the organisms in its original condition. Notwithstanding this, however, the fluctuations of weight-increase progress in harmony.

Whatever it is that thus influences growth comes to us with the speed of the sun's rays; it varies from day to day, its intensity is the same at the same time throughout the globe, and it is not subject to local causes, to changes by wind and by weather.

Malling-Hansen calls this force "energy of growth"; he supposes that it reaches the earth with the speed of the heat-rays; separates from these, undergoes manifold changes, and, spreading over the whole earth, is the cause of the uniform fluctuations in the growth of all organic life. Upon future investigations falls the burden of proof of this assumption.

This influence of the sun-power may serve as an important factor in testing systems of nourishment, in the arrangement of diet-cures, and in studying the action of mineral waters. For instance, what weight can be attached to an opinion formed on the medicinal value of a mineral spring, if the test be made at a time when the energy of growth is on the decrease, and is thus perhaps assisting in the action of the spring, which at some other period might prove itself only half as efficient?

Good nourishment, a limited amount of mental effort, and as far as possible healthful surroundings during the maximum period of growth of girth, may tend to re-establish the right proportion of stature in children who have grown too rapidly.

There is no known reason to doubt that adults gain and lose in the same periods. If persons who are desirous of growing less stout leave the watering-places at the end of August or earlier, they do so at the time of weight-increase, and a careless diet will hence, in shorter time than it would under similar circumstances in winter, cause them to grow stouter again.

With regard to the school vacations, these should be given from the end of June to the beginning of September, during the two maximum periods of growth; the bodily strength which has been gained will aid the mental work.—*Translated for the Popular Science Monthly from Daheim.*

Prof. Gairdner has called attention, in the British Medical Association, to the need of medical students receiving more adequate instruction in physics. The subordination of living bodies and physiological processes to all the most elementary laws of matter; the correlation of all the physical forces; and the medical methods involving applications of pure physics, combine to make this matter an extremely important one. The physical laboratory will probably in a very few years become an essential aid in the education of the physician.

AINU FAMILY-LIFE AND RELIGION.

By J. K. GOODRICH.

UP to the age of three or four years an Ainu child is called *ai-ai* (baby), without regard to sex. From that age until about seven, a boy is called *sontak* and a girl *opere*. From seven until about sixteen or eighteen a lad is called *heikachi*, and a maid *matkachi*. After that age a maid is called *shiwentep*, or woman. From eighteen to thirty a young man is called *okkaibo* or *okkaiyo*; after the age of thirty a man is an *Ainu*—that is, "a man."

The boy is trained in fishing and hunting by his father and the other men of the village, and at the age of about twelve accompanies the men in their manly vocations. The girl assists her mother and the older females of the family in gardening and cooking; in cleaning, salting, and curing fish; in spinning, weaving cloth, and making clothes; and generally in all the drudgery of the household, for the Ainu man is as lofty in his notions that labor is beneath his dignity as is the North American Indian.

While not as demonstrative in their affection for their children, I think the Ainu parents love their little ones quite as tenderly as any other people; and if Miss Bird's observation is correct, they have one pleasant way of displaying their affection which one does not see through the length and breadth of the empire of Japan, and that is the kiss of affection.

There is no ceremony of any kind, nor isolation of the mother, before the birth of a child. As the women are not allowed to offer prayers or take any active part in religious observances, the prospective mother can not ask the gods for their assistance at the time of delivery in order to make parturition easy; indeed, it would probably never enter the head of an Ainu woman to thus interfere with the course of Nature. The father, always preferring sons, and being extremely anxious for a male heir, if he has none already, will pray to the gods to give him a son, and offer libations of *saké* to the goddess of fire, if his means admit of the expense, or his desire is sufficiently keen to justify the extravagance.

Parturition is very easy, due to the active habits of the women, and is greatly assisted by their physical conformation, as they have broad hips and great strength in the pelvic region. The woman continues her daily tasks until the labor-pains actually come on. She then retires to her hut, where she is attended by a few of her most intimate relations, and, if it be her first baby, her mother will doubtless officiate as midwife. As the kneeling position which a woman assumes at the time of delivery greatly facilitates the passage of the child through the pelvis, and tends to expedite the after-birth, the woman in a surprisingly short time resumes her household duties quite as if nothing unusual had occurred. There is no ceremony of purification for the mother, nor does she receive congratulations. On the contrary, it is the

Fig. 1.—Ainu of Yezo.*

father who is congratulated; and when the poor mother has taken up her drudgery once more, it is *he* who remains by the fireside, wrapped up in his good clothes, to receive the felicitations of his relatives and friends, smoking constantly and drinking many a

* For the illustrations in this article we are indebted to "Unbeaten Tracks in Japan," by Isabella L. Bird.—Editor.

cup of *saké*, particularly if the baby be a boy and the heir. I was greatly surprised to find this near approach to the *couvade* in this part of the world, and this one little thing seems to separate the Ainu further than ever from the Japanese.

The children are trained to render strictest obedience to both parents; and if there be several sons, the eldest, as heir, exacts and receives implicit obedience from his younger brothers; from his sisters obedience comes without saying, so low is the social position of women. Adoption obtains to quite the same extent as among the Japanese, and the legal standing of the adopted child seems to be as absolute as if his right were that of birth. Adoption is, however, almost restricted to male children, though I was much surprised to find that one childless couple had adopted a little Japanese girl who was so young that she had never learned to speak the language of her own people.

If a man have only female children he will sometimes adopt an heir, but this is not altogether necessary, since the husband of the eldest girl will usually succeed his father-in-law; and, in order to thoroughly fit himself for his prospective heirship, he moves into his wife's home and becomes a member of her family. But if a couple be childless they will surely adopt a son, for, inasmuch as inheritance is strictly in the male line, there must be some one to take possession of the house and the personal property, and to become the head of the household, Not that it is necessary to continue the family name, for there is nothing of the kind among the Ainu. Each person has but one name, without any prefix or suffix to determine whose child he may be, and the name is often given from a mere whim; as, for example, if a baby-girl pitches upon a dirty old pot as her favorite plaything (and this is a very possible case, for toys are not common), the chances are that she will very soon be designated as "The Pot" or "The Kettle" by the family, and eventually the name will become affixed to her. Hence we may say that names are given to Ainu children very much the same way that nicknames attach themselves to children in America and Europe.

Not only are there no family names, but each person's name dies with its owner; the repetition of a name in different generations having nothing to do with the preservation of the memory of an older person. Children are not named for a rich uncle or a maiden aunt, to secure "prospects" for them. There are no posthumous names as with the Japanese, and a dead person is not spoken of by name if it can be avoided by any circumlocution; indeed, every effort is made to avoid all reference to the dead.

The adoption of an heir is not often necessary, for barren wives are sometimes sent back to their fathers; this misfortune constituting one of the best reasons for absolute divorce among the Ainu, as among savage and barbarous nations the world over.

Children are sometimes betrothed by their fathers when quite young, and this is done without the intervention of a middle-man. This is not usually a matter of commerce, but often occurs when two men, during a drinking-bout, conceive a great friendship for each other. It frequently happens, however, that two rich men, desirous of combining the wealth of their respective families, will betroth their children. But betrothal is not absolutely binding upon the young people, for the veto power remains with the children; and if, upon reaching marriageable age, either of the principal parties to the marriage feels any inclination to do so, he or she will annul the betrothal contract, in which event any presents that may have been given must be returned, or their value fully recompensed to the donors. It is sometimes a difficult matter for the girl to have her own way, for there are conventionalities even in Ainu society; but the boy simply takes the law into his own hands and consummates wedlock with the object of his affection, and, when her condition betrays the fact, opposition often ceases!

At the time of betrothal, if the choice be an independent one on the part of either the groom or bride, it is customary for the fathers to exchange presents, of no great value, to be sure, but sufficient to show their approval of the match. Long engagements are not popular, and when once a betrothal has been effected the pair are soon married, if they are of suitable age—that is, about eighteen or twenty for the man, and sixteen or eighteen for the woman. It will be noticed that there is a certain doubt expressed in all matters pertaining to age, time, etc. This is because the people have no record of time, except to mark the recurring seasons, and do not themselves know how old they are.

When two young people are married, the wedding-feast is usually held at the house of the groom's father. The village chief (or his representative if he can not attend in person) and all the members of the two families attend, with the immediate relatives and the nearest neighbors. Like all their social and religious meetings, the occasion is made an excuse for *saké*-drinking—the men drinking themselves into a state of intoxication. As they are hard-headed fellows, and take their liquor cold (instead of heated, as the Japanese do), the quantity of *saké* consumed is sometimes enormous. To give some idea of the Ainu excessive fondness for *saké*, I may mention the fact that many of the northern Ainu often refuse to work for money-wages, and stipulate that they shall receive *saké* in full payment before they will commence.

The mistress of the house superintends the preparation of the wedding-feast, and is assisted by all the assembled women in pounding the millet and making wedding-cakes, which are boiled, like dumplings. The groom is expected to provide most of the *saké*, if not all of it, as he is supposed to have engaged in manly vocations, to have received his share of the products of hunting and fishing, and to have accumulated enough money to buy the ceremonial wine, or beer rather, as *saké* is a brewed beverage, not a fermented or distilled liquor.

The newly married couple at once take possession of a new, small hut, which has been erected for them. These huts are made with a light frame of poles, the sides and roof being heavily thatched with reeds. They are by no means warm or impervious to the weather; indeed, many breaks in the thatching admit of ventilation to a degree that must lower the temperature in winter to a point well-nigh unbearable. The first hut is usually built upon ground belonging to the bride's father, and near his own house; but the location of the new hut seems to depend in a measure upon the manner of asking in marriage. If the groom or his father asks for the bride, then, to compensate the bride's father for the loss of his daughter, the groom goes to live on his father-in-law's land and becomes a member of his household; but if, on the contrary, the application has come from the other side, and the bride (as may sometimes be the case) or her father has asked for the groom in marriage, then compensation is considered to be due to *his* family, and the bride goes to her husband's land, becomes a member of her father-in-law's family, and assists in the domestic duties of her new home. An exception to this rule may occur when the bride's father has no sons, and asks for a husband for his oldest daughter in order to secure an heir.

When first married an Ainu couple is considered well set up in housekeeping if a small hut is provided with barely sufficient room for them to sleep on the left-hand or northern side of the central fireplace, a tiny little platform at the eastern end, opposite the entrance and under the sacred window, and a space on the right of the fireplace for guests, of about the same dimensions as the sleeping-place. For furniture there will probably be some mats to sit and sleep on, some rugs or skins for covering, a kettle, and a few dishes in which to serve food. As the family increases—and this is almost sure to be the case, for a childless family is unknown unless the fault is the man's—the house is either added to, or (as is more frequently the case) taken down and entirely rebuilt in more and more pretentious proportions, until it has its entrance porch opening to the south, its anteroom in a western extension, and its main apartment, sometimes thirty or forty feet square. Near it will be a small storehouse raised on stilts, and at one side a little patch of garden for beans, millet, etc.

When the newly married couple take possession, a house-warming is held. This, like every Ainu ceremony, is merely an excuse for *saké*-drinking, and, instead of bringing assistance to the young people in their early struggles, rather tends to deplete the none-too-plethoric purse; for the beverage is provided by the groom, whose resources will have been severely taxed when he has furnished *saké* for the marriage-feast and the house-warming as well. At the latter feast a prayer is offered to the goddess of fire, by the village chief or one of the elders, invoking her protection for the house and its inmates, and asking that male children may be numerous and strong. This is called *chisei nomi*.

Marriages are seldom contracted between residents of different villages, and if the Ainu kept anything like a record of blood-relationship, marriage between first cousins would probably be found the rule rather than the exception. But that inhabitants of different villages do intermarry is proved by the fact that they have words in their language to indicate the fact. Thus, *iriwak* means blood-relations, those who are received into the family circle and are close together (a village is virtually a large family), while *iritak* means distant relations, those who are taken away. Again, the names of those who go from their own village to wed with those of a distant village are changed, but whether or not this is done according to any rule is not quite clear; certainly there is nothing in the new name to indicate the birthplace of the person. With increasing facilities for traveling and temptations to wander in search of employment, these marriages out of the family circle are becoming more frequent.

Polygamy is permitted indefinitely, the number of wives being determined by the wishes of the man himself and his ability to secure a plurality—one can hardly say his ability to support them, since the support of the man himself and of his family is mainly provided by the women.

Widows are isolated for a period of three years, during which time each lives in her own little hut, supporting herself as best she can by doing a little gardening and by catching a few fish at night in a semi-surreptitious way. They must wear a distinctive cap during this period, and are not allowed to participate in any of the ceremonies of the village. At the expiration of the three years they doff their caps, resume their places in society, and are once more "eligible," and, if known to be good wives and mothers, are sought after. Old women (widows) with grown-up children are exempted from this enforced seclusion, and are supported by their offspring.

Adultery is strongly opposed by the Ainu, and is severely punished; the guilty parties (unless they are young people who can atone for their crime by marriage) being sometimes strung up by the heels until nearly dead. "The other crimes, recognized by general consent, were theft, incest, murder, suicide, infanticide, disobedience to parents, and idolatry, as well as exposure of person. In ancient times every village was governed by three chiefs subservient to Sara. These chiefs never had absolute authority; all crimes were submitted to the judgment of as many members of the community as cared to be present" (Batchelor).

Inasmuch as there are no family names, no village, tribal, or national rights to be respected, there is nothing approximating to father-right or mother-right. Or perhaps it would be more exact to say that, inasmuch as women are only recognized as servants throughout their whole lives, and as mothers as soon as they have reached the proper age, the personality of the whole family is sunk in that of the husband and father while he lives. When he dies he is at once and absolutely forgotten (except so far as is mentioned hereafter), and each surviving member of his family pursues an entirely separate course, in no way concerning himself about the others. If a man dies and leaves a family of infant children, the care of them devolves upon the mother until the oldest son reaches the age of about eighteen; then he becomes the head of the family. Female inheritance is utterly unknown, as would be expected in a society wherein women have no rights at all. If a man is so unfortunate as to leave no true heir, or so careless as not to have adopted one, his property goes to his next younger brother, or his nearest male relative, if he have no brothers either by birth or adoption.

When very sick, an Ainu *man* (the women may not pray at all) will call upon the fire-goddess, who is reckoned a great purifier, thus: "*Abe kamui, yekoingara wa en-kore*" ("O fire-goddess, condescend to look upon me"). Upon the approach of death, the master will lie close to the fire on his own side of the hearth, partly for the sake of the warmth, but probably in a measure for any possible benefit to be gained from propinquity to the realm of the fire-goddess. Then the village chief and elders, and the sick man's friends, all come to see him; the men to pray and "drink to the gods," while the women weep and wail in rather a noisy fashion, since they are denied the comforts of religion! There are times when the patience of the praying men becomes exhausted, if no favorable answer is given to their petitions. Mr. Batchelor tells of one death-scene which he witnessed when two men were praying to the goddess of fire and another toward the sun-rising through the eastern window; while a fourth was looking toward the northeast corner of the hut (which corresponds in a measure to the *latrine* of Japanese houses) and swearing most vehemently at *all* the gods, something after this fashion: "You fools! why don't you pay some attention to us? Can't you see that this man is in great danger? Here we've been praying and praying for him, and yet he doesn't get well. What's the matter? Are you deaf? Can't you hear us?"

When death actually takes place, and the friends are convinced by the coldness of the body that there is absolutely no hope of recovery, preparations for burial are immediately begun. The corpse is not washed or anointed in any way, embalming being quite unknown to this people: it is dressed in its newest clothes; the outer garment, which reaches nearly to the feet, is folded over the body and neatly laced up in front like a boot, and further secured by the girdle. The feet and ankles are carefully wrapped, when possible, in white rags, and the hands and arms are similarly covered. The man's bow and quiver and his gun are laid by his side, and his pipe and tobacco-pouch are stuck in his belt. With the possible exception of the smoking implements, these articles are not interred with the corpse, but are simply placed as insignia of its manhood during the funeral feast which immediately takes place. For this feast, cakes made of millet-flour, and boiled somewhat in the same manner as dumplings, are prepared by the widow and female relatives of the deceased. They are similar to those used at the wedding-feast. The cakes are eaten by the men who assemble for the occasion, by whom a great deal of *saké* is drunk. A small libation is offered to the man's memory and to the gods. In doing this the men dip one end of carved flat sticks, which they use as mustache-lifters, into the *saké* and sprinkle a few drops toward the corpse, the fireplace, the east window, the northeast corner of the house, and round in front of them generally. The act of drinking the *saké* is in itself a religious one, as they say that in "drinking to the gods" they show their reverence; therefore the more they drink the better, and an occasion when all become intoxicated to absolute stupefaction is by some thought to give pleasure to the gods and to be blessed by them. As the village chief is its priest and performs all religious ceremonies, his presence at the death-feast is essential. He conducts the ritual—if the orgies may be dignified by that term—the men all participating, and the women acting as servants. If for any reason the chief himself is unable to be present, he sends a substitute.

When the cakes are eaten and the *saké* all drunk (and the men sufficiently recovered from its effects to be able to move), the body is slung upon a pole, borne to the grave by the nearest male relatives, and immediately buried. No particular time is chosen, nor is any attention paid to the situation of the grave. This seems very strange when it is remembered that the east is considered the sacred direction, and one would naturally suppose that some care would be taken to place the corpse in an east and west line, perhaps with the head slightly raised and looking toward the rising sun. But such is not the case: a shallow grave is dug, the body—rolled in a good mat—is tumbled in, a few stones perhaps thrown in to prevent animals from disturbing the remains, the dirt hastily replaced, and the corpse is left to its fate. Sometimes the pipe and tobacco-pouch, or a small package of tobacco, will be buried with the man, if he has been specially fond of smoking. This fact, and the additional one that a stout stick or club is provided to furnish the man with means of defense, point to a belief in a transition state, but the Ainu has only a hazy idea of the hereafter, and particularly as to purgatory, or the passage of the soul, which is thought to be naturally immortal, to the reward or punishment it is to receive in *Pokna moshiri*. "The wicked are supposed to be harassed by the evil spirits—*nitne kamui*—in this place, but what the rewards of the righteous are the Ainu have no idea."

It is customary to put up a short stick at the head of a grave, the carved top of which indicates the sex of the person therein buried. If it is a man, the top of the stick will be cut in the shape of a spear-head; if a woman, it will be a rudely shaped ball. There is nothing to correspond to a tombstone either at the grave or in the village, where there is no temple, as in every Japanese village, with memorial tablets and altars to keep alive the memory of the deceased. Indeed, it appears to be the desire of the Ainu to forget the dead as soon as possible; their reluctance to speak of them is an evidence of this. In the case of women this is absolutely so, a possible exception is mentioned below. In the case of a man, his son may offer a small libation of *saké* at his grave, and at the *inao* raised to his memory at his former home, on the anniversary of his death; and, in the case of a prominent chief, the men will perhaps do this for two or three years—never for a longer time. These anniversaries are really made excuses for *saké*-drinking rather than true testimonials of respect.

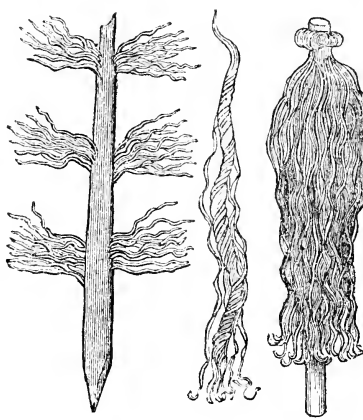

FIG. 2.—INAO OF THE AINU.

The *inao* spoken of above are whittled willow sticks with pendent, curl-like shavings, offerings given to the gods (with the libations of *saké*) at the time of worship. Miss Bird (volume ii, p. 86) gives an illustration of them and calls them "Aino gods." I think this is a mistake, just as it would be a mistake to call the images, relics, etc., in a Romish church "gods" in the sense of being possessed of absolute power in themselves. One large *inao* is always placed at the eastern end of the hut for the sun-god, and many of them are hung all round the inside of the hut; generally one or more are stuck into the fireplace; and there is always at least one at every spring of water. At least one will be placed at the head of a man's grave; and several will be stuck into the ground at the rude wicket on which are impaled the skulls of bears—these animals occupying a somewhat anomalous place in Ainu philosophy; at one time feared and worshiped, at another killed and eaten.

Although the Ainu ideas of a future existence are very hazy, yet they consider that the spirits of men are well-disposed toward the living, and may be relied upon to bring good fortune to the village and the inhabitants thereof; hence they have no fear of the spirits of men; but it is very different with those of old women. They are considered to be very malignant—witches, in fact—who are seeking some means of working mischief. Formerly this prejudice was more deeply rooted than at present, and, in order to prevent the spirits of old women bewitching the place and the people, their houses were burned down as soon as ever the corpse was taken away for burial. This was done in order that the spirit might have no abiding-place, and, while engaged in hunting for its home, would be diverted from its malicious plans. This notion corresponds with the superstitions of barbarous nations in other parts of the world.

There does not seem to have ever been any superstition connected with the fireplace, as to the manner of procuring the flame when first kindling a fire in a new house, nor as to the necessity of always keeping the fire alight to ward off misfortune. Charcoal is not used, and as the wood is generally in small pieces, the fire is easily extinguished, but this does not bring any bad luck. The use of the Japanese *hibachi* (brazier) and small fire-pots is becoming popular, but this is such a purely exotic custom as not to deserve mention. Formerly the Ainu used the fire-drill, in all essentials similar to that of the Esquimaux of North America; but for many years matches (at first imported from America and Europe, but now manufactured in enormous quantities in Japan) have been so cheap that even the Ainu can use them.

The Ainu bear-feast has been so often described, and the prominent features thereof so well portrayed by others, that I will not attempt to do more than mention one or two points which have not, I think, been given already, only repeating that the festival of killing and eating the bear, which has been kept in a cage since its capture when a cub, is a sort of religious affair, and is made the occasion for much *saké*-drinking, and that a curious dance is performed, in which men alone take part. The feast is held in February or March (I do not make this statement in absolute contradiction of what Miss Bird says, but admit that custom may vary the time in different villages). Among the northeastern Ainu, Kusuri, and Nemuro, the women, who are officiating as cooks and attendants, provide large vessels of wild strawberries (which must be kept over from the preceding summer), mix the juice with water, and smear the faces of all the people who are present, even to the alien guests. All must submit, as a token of friendliness This is a strange custom, and is possibly done to indicate that the bear-feast resembles something of a bloody sacrifice, for the Ainu say that the strawberry is used because the color of its juice approaches that of blood.

I will close my rambling notes on these people by an account of what I saw in one or two of their villages on the day of the eclipse of the sun (August 19, 1887). First let me say that they think an eclipse is the effect of great sickness, which causes the sun's face to become black, as does a human being's (sometimes) when in a fit or on fainting away. I left the village of Horobetsu, on the south coast of Yezo, at about two o'clock. It was evident that the Ainu had been told of the impending disaster, for many of them were standing outside of their huts, glancing anxiously at the sun from time to time, and talking together in low, earnest tones which betrayed their apprehension. When we reached the next village, Washibetsu, the shadow of the moon had covered a good-sized segment of the sun, and the people were greatly excited. Many men were looking at the sun and moving their lips as if praying, while some had brought dishes of water, and were throwing the water toward the sun with their mustache-lifters and *inao*, just as we would dash it in the face of a person who had fainted away, to revive him. By the time we arrived at Mororan, the next village, the eclipse was all over; the excitement had pretty nearly subsided, although a few persons were watching the sun rather closely, as if afraid that he might have a relapse and require to be revived again.

As I have tried not to go over ground which has been well worked by previous observers, I have omitted many details of the Ainu manners and customs, and it seems proper for me to give a list of books and publications, which may be referred to by those whose interest will have been sufficiently aroused to make them anxious to know more of the "Hairy People of Japan":

"Transactions of the Asiatic Society of Japan." In many numbers there are articles of more or less interest. Special attention is called to "Notes on the Ainu." By J. Batchelor. Vol. x, part ii.

"The Japan Weekly Mail." Yokohama. This newspaper contains many valuable articles on the ethnology of Japan in general, and the Ainu in particular.

"The Language, Mythology, and Geographical Nomenclature of Japan. Viewed in the Light of Aino Studies, including a Grammar of the Aino Language, by J. Batchelor." By Basil Hall Chamberlain. Memoirs of the Literature College, Imperial University of Japan. No. 1. Tōkyō, 1887.

"Unbeaten Tracks in Japan." By Isabella L. Bird. London, 1882. Two vols. The second volume contains a graphic and picturesque account of the author's sojourn among the Ainu.

"The Stone Age in Japan." By John Milne. Paper published in the "Journal of the Anthropological Society," May, 1881.

"Der Baerencultus und die Baerenfeste der Ainos, mit einigen Bemerkungen ueber die Taenze derselben." By Dr. B. Scheube. Paper published in the "Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens." December, 1880. Treats of Ainu bear-wishop and dancing.

"Die Ainos." By Dr. B. Scheube. Paper published in the "Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens." February, 1882.

"Ethnologische Studien über die Aino auf der Insel Yesso." By Heinrich von Siebold. Berlin, 1881. Illustrated.

"Japan in Yezo." By T. W. Blakiston. Yokohama, 1883.

"Reisen und Forschungen im Amurlande." By L. von Schrenck. Vol. iii contains much valuable information about the Ainu, gathered from many sources.

THE PROLONGATION OF HUMAN LIFE.

By CLEMENT MILTON HAMMOND.

IN order that one may live to near the limit in years of human life, must he inherit some peculiar qualities? Must he conform his habits to some set rules? Must he eat and drink certain things and abstain from certain others? Or, does it all depend upon a series of indeterminable accidents?

There have been many theories, and perhaps a pageful of facts, given to the world upon the subject during the past few centuries, but no thorough, systematic study of these questions has been made. All that we know about the things that seem to govern the length of man's life is what we have learned from limited observation and the small number of cases that have been imperfectly recorded in history or in medical works. It occurred to me that if accurate statistics could be collected about one thousand men and women, over eighty years of age, living in New England to-day, such information would form the basis of some very interesting and very valuable conclusions. In my position as associate editor of the "Boston Globe" I found this a comparatively easy task. I had five thousand blanks printed, asking for the following information in relation to men and women over eighty:

Name, residence, age, nationality; whether married or single; general description, including size, weight, complexion, etc.; children, how many, ages, state of health, etc.; habits, hours of rising, retiring, meals, exercise, etc.; occupations, past and present; food and drink, quantity, kind, etc.; attacks of sickness if any, and at what ages, nature of disease, etc.; condition of teeth, hair, beard, skin, etc., at time when seen by the correspondent; age at which father and mother died, and of grandfather and grandmother, whenever possible.

These blanks were sent to the representatives of the paper in all parts of New England, accompanied by a letter of explanation which cautioned them to be accurate rather than enterprising. More than three thousand five hundred of these blanks were filled out and returned in the course of two months, and the story that they tell I will try to give in outline.

Every county in Massachusetts, and nearly every county in the whole of New England, is represented in these returned blanks. Some of these old people live on the sea-coast, some on the lowlands of the Connecticut and its tributaries, some among the Berkshire Hills, White and Green Mountains, some upon the sands of Cape Cod, some among the pine-woods of Maine, and others in the manufacturing cities and towns. The canvass has not, of course, been complete, but it has been as complete in the cities as in the towns and on the farms, as complete in one section as in another, as complete among one class as among another. If these three thousand five hundred instances prove anything — and I think no one will dispute that they do—many of the commonly accepted theories would be overturned, and strange facts take their places.

In looking through these blanks, the first thing noticeable is that few of New England's old people have remained unmarried throughout life, the total being less than five per cent. The ratio of unmarried women to unmarried men is about three to one, and, taking married and single together, the women exceed the men by 251. In Massachusetts the list shows that the women exceed the men by 450; in the other States the men exceed the women. The great majority of both men and women have been married only once, usually in early life. The average number of children as a result of these unions is five, and those children now living are generally recorded in the blanks as healthy.

The fact that in Massachusetts, taking the whole population into account, the women exceed the men by several thousand, accounts in some degree for the greater number of old women, but not, certainly, for anything like half of the excess over the men. I attribute this excess to the fact that during the past half-century the bulk of the population of Massachusetts has been on the seaboard, and a large number of the men have been fishermen and mariners. Because of the great loss of life among this class, especially before the time of steamships and during the palmy days of the whale-fishery, the male population shrank in numbers below the normal level, this showing most strikingly in a list of old people.

Another very peculiar thing revealed by this canvass is the fact that five out of six of these New England old folks have a light complexion, with blue or gray eyes, and abundant brown hair. In stature the men are mostly tall and the women of medium height; in weight the men range from 100 to 160 pounds, with a few of 200 and over, and the women from 100 to 120, with exceptional cases of 180 and over. Throughout life the men have been bony and muscular, the women exactly opposite. The condition of the hair, teeth, beard, and skin of these old people at the time when the blanks were filled out was recorded in about 2,500 instances. In nearly all the hair remains thick, the teeth are very poor or entirely gone, the skin is only slightly wrinkled, and very few of the men wear any beard. In many instances the correspondents speak of the skin as being "fair, soft, smooth, and moist." One case is given, that of a man of eighty-nine, from whose mouth not a tooth has been lost. In most instances of those not over ninety the eye-sight is still good, and in dozens of cases it is pronounced "remarkably good."

Habits.—The information which the blanks give on the subject of habits coincides with the opinion of most people, formed from observation, that longevity without regularity of habits is rare. These old people, men and women alike, are put down as early risers and retirers, almost without exception, and fully nineteen out of every twenty have observed this custom throughout life, except perhaps at some short period in youth. Meals have been eaten regularly, three each day, with dinner at noon, the exceptions being so rare as to indicate nothing. Exercise in most cases has been hard work up to sixty-five or seventy, and after that period has consisted (when the regular occupation has been given up) of walking, gardening, or both. Except in cases of sickness these old people are as a rule as active and as fond of constant occupation of some sort to-day as most men and women are at thirty-five.

Occupations.—One of the most significant facts gathered in this canvass is that regarding occupations. Out of 1,000 men, throughout life 461 have been farmers; 92 have been carpenters; 70, merchants; 61, mariners; 49, laborers; 42, shoemakers; 41, manufacturers; 23, clergymen; 23, masons; 16, blacksmiths; 16, bankers; 12 each, iron-workers, mill-hands, physicians, and lawyers; and the rest are divided among nearly all the other trades and professions. The list includes only one each of the following: Hermit, hunter, chemist, professor, soldier, broker, auctioneer, jockey, contractor. Nearly all, however, began life upon the farm.

Eight hundred out of twelve hundred women have been farmers' wives, and all but about fifty of the remainder have been housewives. Four women only, all unmarried, have supported themselves through life by inherited wealth, and are now aged respectively eighty-two, eighty-three, eighty-six, and ninety. Three other unmarried women have been milliners, and six, one unmarried, have been dress-makers. Seven, two unmarried, have been nurses. Six, two unmarried, have been school-teachers.

Among the hundreds of remarkable instances which illustrate constancy of occupation cited by the correspondents are a few that I can not refrain from giving, because I believe that they point to a very important fact, and at the same time make most interesting reading:

Elijah Tolman, of Brockton, Mass., is eighty-five, and was a stage-driver for thirty years. For the past seven years he has worked in charge of a coal-office, and has been but one day from his duties in that time.

Andrew Stetson, of Duxbury, Mass., is ninety-five, and was constantly employed all his life making shoes until one year ago.

Aaron Farnham, of Cambridge, Mass., aged eighty-seven, sold Bibles in Vermont for seventy years.

Daniel Bigelow, of Athol, Mass., now eighty-seven, has worked as a farmer for seventy-seven years, and mowed grass with a scythe for seven tons of hay the past summer.

William E. Cook, of Portsmouth, R. I., is eighty-nine, a blacksmith, and still works in his shop six days each week.

Ira Chamberlain, of Bangor, Me., aged ninety-five, worked at the tailor's trade until his last birthday.

Thaddeus Rising, of Hatfield, Mass., is eighty, and works daily, as he has for the past sixty years, at his trade of whip-maker.

Mrs. Jane Huntress, of Augusta, Me., ninety-two years of age, still does her own cooking, washing, ironing, and garden-work. Since she was fifty-five she has earned the money for and built a fine house, going herself to the mill and selecting the lumber, and superintending the building operations. She is one of twelve children, all born without the aid of a physician.

Food—Drink—Stimulants.—The blanks tell one simple story, with so few variations as to be positively monotonous, in relation to the food eaten by these old people. The diet has been regular New England home-dishes of meat, vegetables, and pastry, with breakfast early, dinner at noon, and supper late. Very few are mentioned as small eaters or large eaters; most are mentioned as not particular, with good appetites through life. A half-dozen never eat meat, and two have abstained from water. More than two thirds have been habitual users of tea and coffee, and of the remainder nearly all have drunk tea. Few of the men, and none of the women, are given as users of more intoxicating beverages than cider, and not a dozen out of all have ever used liquors to excess. Ten of the women are mentioned as habitual smokers, and a score as snuff-takers. Of the men, a large majority have used tobacco—either chewing, smoking, or both. Most of the tobacco-users have been moderate, although numbers of cases are given where the amount consumed is enormous, and continued constantly up to the time when the census was taken. A few broke away from the habit after it had lasted for twenty, thirty, or fifty years, and have now been without the narcotic for perhaps a decade or more.

Sickness.—The record of sickness is so varied that scarcely half a dozen cases are alike out of the whole long list, except where there has been no illness other than the usual complaints of infancy.

Out of 1,049 men, 382 never were ill since early childhood; and of 880 women, 286 have enjoyed the same good health. One hundred and fourteen men and 171 women have had petty diseases only, and 495 men and 402 women have been seriously ill. The serious illness of the majority was a fever of some sort, typhoid heading the list. The other diseases are as numerous almost as the individuals afflicted, running from Asiatic cholera to shingles, and the attacks have been at all periods of life. As might be supposed, rheumatism is the most general complaint, usually in conjunction with other diseases. Locality seems to have had no influence on sickness, the same disorders appearing on high land and on low land, on dry land and on moist land, in the interior and by the sea-shore.

Parents and Children.—The average age reached by the parents and grandparents, taken together, of these old people was about sixty-five, and in few instances have both the father and mother or the grandfathers and grandmothers died under fifty, although in many cases—about twenty-five per cent—either the father or the mother has died before reaching this age. Not over one third of the children of these aged people have reached middle life, and about one half died either in infancy or before thirty, and about one fourth only are still living. The health of the latter, however, is in almost every instance put down as good. The blanks do not tell what would, perhaps, be a valuable thing—how many brothers and sisters the subjects had, and whether or not they died young; it appears, though, from the names, that few members of the same family have survived, unless it is supposed that the remaining members were older and have died, or enough younger to come under the eighty-year limit.

Some Conclusions.—Perhaps it is true that only an expert or a philosopher should draw conclusions. I pretend to be neither one nor the other, yet I think a familiarity with the facts gathered about these hundreds of old people will excuse anything on my part that might at first thought look like presumption. What I have tried to learn from this vast amount of information that has been collected about these examples of long life are these things:

What is the influence of the different occupations upon length of life?

Does the physical build of a person have anything to do with the length of his life?

Can one so regulate his habits of work, sleep, eating, drinking, use of stimulants and narcotics, and exercise, as to prolong life?

Is there such a thing as an inherited tendency to long or short life?

Few of the people accounted for by this census are employés, unless the housewives be called such, and in New England I certainly think they can not be. The occupation that claims most of the men is farming, which means dependence on circumstances and not on men. Of the men and women alike, throughout the list, they are the exceptions who have not been weighted with responsibilities, but responsibilities which, by being borne without intermission, have become fixed habit. The fact that so many of these old people are not employés, considered in conjunction with the fact that the great mass of mankind is made up of wage-workers, points toward a very important conclusion. It seems evident either that a man with the elements of long life within him is more independent in his nature or that a spirit of independence fostered for years tends to prolong existence. It needs no collection of statistics to prove that, in most cases, one who works during a long period for another has a weaker individuality than he who is an employer. The brain of the wage-worker may weigh and measure as much, and his physical strength may be as great, as his who takes the risk of profit and loss upon himself, but in New England, at least, his life is not so long as the average, and it is rare, as the statistics show, that he lives beyond the age of eighty. This result can not, certainly, be due in any considerable degree to amount of labor, to irregularity, or in any degree whatever to care—supposed to be so deadly in its effect—or to want of nourishing food.

I doubt also if any well-informed person will claim that sanitary conditions have any influence, certainly not if he knows as much as I do of the conditions under which the bulk of these people whom we are considering live.

Very few instances are given where occupations were changed except in the cases of the mariners, who have mostly become farmers in a small way. The life of nearly all these people has been what is usually considered a monotonous one, with regular hours of steady labor and moderately sure returns. Few appear to have taken many risks in life, and while most of them have carried more than the average New-Englander's share of mental and physical burdens, these burdens have been so evenly distributed throughout life that the strain has not been jerky. Surely the housewife has more cares than the woman who works in a shop or as a house-servant, and yet her cares are so similar day after day and year after year that they become easy to bear. So also with the farmer compared with the clerk or mill-hand. Few in all the list have been either more or less than moderately successful—successful above the average, to be sure, but they have achieved neither notoriety nor wealth. They have, in fact, been placed above the wasting worry of want, and have, on the other hand, escaped the softening of the tissues and aimlessness of purpose that generally accompany wealth easily and rapidly obtained.

I have alluded to the fact that in the subjects of the census the complexion in most instances is light. While this may be due to the northern origin of the majority of New England people, and have no special bearing upon the subject of longevity, it may possibly be very important as showing the effect of temperament upon the length of life. That the sanguine temperament predominates in these people is undoubtedly a fact, and it appears that the sanguine-nervous (judged from complexion, color of the eyes, and general build) is most common. In theory, certainly, this temperament is that which would most conduce to longevity. Other facts, of the nature of these gathered in New England, from some other locality, might offset these and disprove the theory; but, until these other facts are gathered, I think the theory that people with nervous-sanguine temperaments, and the two nicely blended, are liable to live longer than those who possess a nervous-bilious or a bilious-lymphatic temperament, with either predominating, is strong enough to work with; and, while it does not directly teach us how to live longer, it points to something in the future that means a great deal to the human race.

The fact that the majority of the men are bony and muscular, and the women plump, is easily explained, I think, by the occupations. In the work of the men their muscles have been brought into play so much, and have used such a large proportion of the nourishment taken into the system, that fat could not accumulate. With the women the reverse has been true, especially after they reached the age of fifty, when grown-up daughters took the hardest of the work from their mothers' shoulders.

In regard to food, the evidence is so uniformly one way that those who advise a simple diet, and those who cry out against meat, must either hold their theories to be above facts or give them up. There is certainly nothing "simple" about the diet of a New England farmer. It consists of salt and fresh pork and beef and all sorts of common fish and vegetables, almost always poorly cooked, and pies and cakes of the most indigestible sorts. The food is "plain," truly, and gives the digestive organs an abundance of work to do, but it is not such food as a theorist would recommend to one who desired to live near up to the century-mark. Tea and coffee have certainly proved that they do not tend to shorten life, even if they do not prove that they help to prolong it. The generally accepted theory in relation to stimulants, that in excess they are not life-sustaining, receives strong support. Tobacco appears to prove itself harmless, at least on the temperament of these people. Whether it be a help to live long requires other evidence.

While the farmers of New England and their wives are a cleanly people, they are not much given to bathing. This neglect may not have prolonged their existence or made them more healthy, but it is to be presumed that it has not cut off many years or caused much disease. Neither are the members of these households well informed in relation to sanitary matters. They know little of the unseen dampness to which the human system is so constantly exposed, and, knowing little, care little. May not this be an influence in favor of a prolonged existence, paradoxical as the supposition may seem? In Hingham, Mass., with only four thousand inhabitants, there are eighty people over eighty years of age, and out of these seventy-five are of light complexion. In no other town in New England, so far as could be learned, is there such a proportion of old people. This town is on the sea-coast, lies very low, is without sewers, and has only recently put in a system of water-works. From a sanitary point of view the conditions here are about as unfavorable to long life as could be conceived outside the crowded portions of the large cities. And in Boston, where the sanitary conditions appear to be the worst—in the North End and South Boston districts—the greatest number of very old people are found.

From the hours of retiring and rising given I judge the average length of sleep to be about eight hours, with few exceptions. Regularity in hours of work, eating, sleeping, and everything in fact, seems to have been rigidly observed. But is not this more the result of the temperament than the cause of long life? Is not the nervous-sanguine temperament more than any other like a balance-wheel or the pendulum of a clock? Is it not, after all, the great regulator of which the habits of these people are a manifestation, and to which is due their long life? And is it not something more than a regulator; is it not a repairer of waste and decay, a remedy more potent than any drug? I will not presume to answer these questions, for some of my more learned medical friends should be much better able to do so in spite of these new facts which I have.

Without more accurate and more complete information in relation to the ages of the parents, grandparents, great-grandparents, and the brothers and sisters of these people in question, it is very difficult to make any deductions pertaining to hereditary longevity. Out of all the statistics that have been gathered there are none which are full or accurate enough to base any theory upon, other than that a *tendency* to long life *may* be transmitted from parents to children. To gather the necessary statistics in relation to, say, one thousand people, from eighty to ninety, would be extremely difficult, but it must be done before scientific thinkers can make deductions.

In order to mention all of the really remarkable things shown by this collection of facts, I should be obliged to make a serial of this article. I have tried to mention those only which seemed most interesting and important. One thing, to me, seems to stand out above all others: that a strong vital principle, manifested outwardly by firm build and constant activity, has been the chief cause of the advanced age of these people. Given a certain organization of mind and body, I think that a man may count on long life—always barring accidents—with reasonable certainty. Such an organization need not be put under any particular conditions of life; it will seek them out for itself, as a plant seeks out in the earth and the air such elements as aid its development. There is no reason that science can see why a raven should live longer than a snipe, but there is a reason, nevertheless: so we can see no reason why a tall, bony, muscular, light-skinned farmer should live longer than a short, stout, dark-skinned clerk; but I believe there is one, and one that science may some day discover.

I have one suggestion to make: that our national Government, when it takes the next general census, include in its statistics information about all the people in the United States above ninety, the kind of information to be determined beforehand by the most eminent physicians and scientific men generally in this country or in the world. I believe that such information would be of more value to the world, after having been properly digested, than all the facts about the manufacture of cotton cloth, the raising of tobacco, the production of whisky, etc., that could be collected in a century. For do we not all desire to live long?

PROBLEMATICAL ORGANS OF SENSE.*

By Sir JOHN LUBBOCK.

IN addition to the organs of which I have attempted in the preceding chapters to give some idea, and to those which from their structure we may suppose to perform analogous functions, there are others of considerable importance and complexity, which are evidently organs of some sense, but the use and purpose of which are still unknown.

"It is almost impossible," says Gegenbaur,† "to say what is the physiological duty of a number of organs, which are clearly sensory, and are connected with the integument. These enlargements are generally formed by ciliated regions to which a nerve passes, and at which it often forms enlargements. It is doubtful what part of the surrounding medium acts on these organs, and we have to make a somewhat far-fetched analogy to be able to regard them as olfactory organs."

Among the structures of which the use is still quite uncertain are the muciferous canals of fishes. The skin of fishes, indeed, contains a whole series of organs of whose functions we know little. As regards the muciferous canal, Schultze has suggested ‡ that it is a sense-organ adapted to receive vibrations of the water with wave-lengths too great to be perceived as ordinary sounds. Beard also leans to this same view. However this may be, it is remarkably developed in many deep-sea fish.

In some cases peculiar eye-like bodies are developed in connection (though not exclusively so) with the muciferous canal. Leuckart,# by whom they were discovered, at first considered them to be accessory eyes, but subsequent researches led him to modify this opinion, and to regard them as luminous organs.

* From "The Senses, Instincts, and Intelligence of Animals," by Sir John Lubbock. "International Scientific Series," vol. lxiv, in press by D. Appleton & Co.

† "Elements of Comparative Anatomy."

‡ "Ueber die Sinnesorgane der Seitenlinie bei Fischen und Amphibien," "Arch. für mic. Anat.," 1870.

"Ueber muthmassliche Nebenaugen bei einem Fische." Bericht über die 39 Vers., "Deutscher Naturforscher," Giessen, 1864.

Ussow* has more recently maintained that they are eyes, and Leydig considers them as organs which approach very nearly to true eyes ("welche wirklichen Sehorganen sehr nahe stehen"). Whatever doubt there may be whether they have any power of sight, there is no longer any question but that they are luminous, and they are especially developed in the fishes of the deep sea.

These are very peculiar. The abysses of the ocean are quite still, and black darkness reigns. The pressure of the water is also very great.

Hence the deep seas have a peculiar fauna of their own. Surface species could not generally bear the enormous pressure, and do not descend to any great depth. The true deep-sea forms are, however, as yet little known. They are but seldom seen, and when obtained are generally in a bad state of preservation. Their tissues seem to be unusually lax, and liable to destruction. Moreover, in every living organism, besides those usually present in the digestive organs, the blood and other fluids contain gases in solution. These, of course, expand when the pressure is diminished, and tend to rupture the tissues. The circumstances under which some deep-sea fish have occasionally been met with on the surface bears this out. They are generally found to have perished while endeavoring to swallow some prey not much smaller, or even in some cases larger, than themselves. What, then, has happened? During the struggle they were carried into an upper layer of water. Immediately the gases within them began to expand, and raised them higher; the process continued, and they were carried up more and more rapidly, until they reached the surface in a dying condition.†

It is, however, but rarely that deep-sea fish are found thus floating on the surface, and our knowledge of them is mainly derived from the dredge, and especially from the specimens thus obtained during the voyage of the Challenger.

In other respects, moreover, their conditions of life in the ocean-depths are very peculiar. The light of the sun can not penetrate beyond about two hundred fathoms; deeper than this, complete darkness prevails. Hence in many species the eyes have more or less completely disappeared. In others, on the contrary, they are well developed, and these may be said to be a light to themselves. In some species there are a number of luminous organs arranged within the area of, and in relation to, the muciferous system; while in others they are variously situated. These luminous organs were first mentioned by Cocco.‡ They have since been stud-

* "Ueber den Bau der sog. augenähnlichen Flecken einiger Knochenfische," "Bull. Soc. Imp. Moscow," 1879.

† Günther, "Introduction to the Study of Fishes."

‡ "Nuovi Ann. dei Sci. Nat.," 1838.

ied by Günther, Leuckart, Ussow, Leydig, and Emery. Lastly, they have been carefully described by Günther, Moseley, and von Lendenfeld, in the work on "Deep-sea Fishes," in vol. xxvii of the "Challenger Reports." The deep-sea fish are either silvery, pink, or in many cases black, sometimes relieved with scarlet, and, when the luminous organs flash out, must present a very remarkable appearance.

We have still much to learn as to the structure and functions of these organs, but there are cases in which their use can be surmised with some probability. The light is evidently under the will of the fish. It is easy to imagine a Photichthys (Fig. 1) swimming

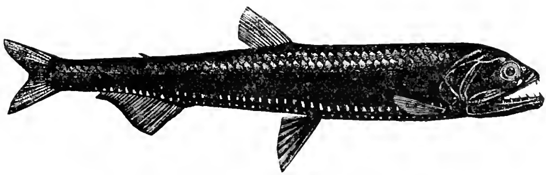

FIG. 1.—*Photichthys argenteus* ("Challenger Reports," vol. xxvii).

in the black depths of the ocean, suddenly flashing out light from its luminous organs, and thus bringing into view any prey which may be near; while, if danger is disclosed, the light is again at once extinguished. It may be observed that the largest of these organs is situated just under the eye, so that the fish is actually provided with a bull's-eye lantern. In other cases the light may rather serve as a defense, some having—as, for instance, in the genus *Scopelus*—a pair of large ones in the tail, so that "a strong ray of light shot forth from the stern-chaser may dazzle and frighten an enemy."* In other cases they probably serve as lures. The "sea-devil," or "angler" of our coasts, has on its head three long, very flexible, reddish filaments, while all round its head are fringed appendages, closely resembling fronds of sea-weed. The fish conceals itself at the bottom, in the sand or among sea-weed, and dangles the long filaments in front of its mouth. Other little fishes, taking them for worms, unsuspectingly approach, and themselves fall victims.

Several species of the same family live at great depths, and have very similar habits. A mere red filament would, however, be invisible in the dark, and therefore useless. They have, however, developed (Fig. 2) a luminous organ, a living "glow-lamp," at the end of the filament, which doubtless proves a very effective lure.†

These cases, however, though very interesting, throw little light on the use of the muciferous system in ordinary fish, which, I think, still remains an enigma.

* Günther ("Challenger Reports," vol. xxvii). † Günther, "Study of Fishes."

In some of the lower animals the nerves terminate on reaching the skin at the base of rod-like structures similar, in many respects, to the rods of the retina, or the auditory rods of the ear, and of which it is very difficult to say whether they are organs of touch or of some higher sense.

Round the margin of the common sea-anemone is a circle of bright blue spots, or small bladders. If a section be made, there

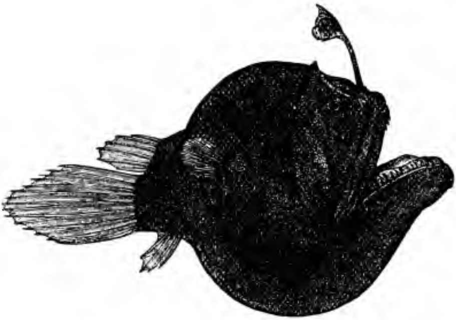

Fig. 2.—*Ceratius bispinosus* ("Challenger Reports," vol. xxvii).

will be found a number of cylindrical organs, each containing a fine thread, and terminating in a "cnidocil"; and, secondly, fibers very like nerve-threads, swelling from time to time with ganglionic expansions, and also terminating in a cnidocil. These structures, in all probability, serve as an organ of sense, but what impressions they convey it is impossible to say.

Some jelly-fishes (*Trachynemadæ*) have groups of long hairs arranged in pairs at the base of the tentacles (Fig. 3), which have been regarded as organs of touch, and it is certainly difficult to suggest any other function for them. They are obviously sense-hairs, but I see no reason for attributing them to the sense of touch.

The so-called eyes of the leech, in Leydig's* opinion, which is confirmed by Ranke,† are also developed from the supposed special organs of touch. The latter are much more numerous, as many as sixty being developed on the head alone. They are cylindrical organs, lined with large nucleated refractive cells, which occupy nearly all the interior. A special nerve penetrates each, and, after passing some way up, appears to terminate in a free end.

I may also allude to the very varied bristles and cirrhi of worms, with their great diversity of forms.

* "Die Augen und neue Sinnesorgane der Egel," "Reichert's Arch.," 1861.

† "Beit. zu der Lehre von den Uebergangs-Sinnesorganen," "Zeit. für wiss. Zool.," 1875.

Among insects and crustacea there are a great number of peculiarly formed skin appendages, for which it is very difficult to suggest any probable function.

The lower antennæ of the male in Gammarus, for instance, bear a very peculiar slipper-shaped organ, situated on a short

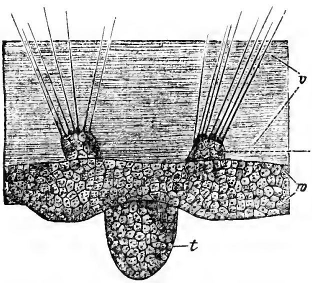

FIG. 3.—EDGE OF A PORTION OF THE MANTLE OF *Aglaura hemistoma*, WITH A PAIR OF SENSE-ORGANS (after Hertwig). *v*, velum; *k*, sense-organ; *ro*, layer of nettle-cells; *t*, tentacle.

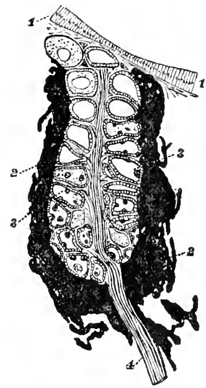

FIG. 4.—SENSE-ORGAN OF LEECH (from Carrière, after Ranke). 1, epithelium; 2, pigment; 3, cells; 4, nerve. The longer axis equals ·4 mm.

stalk: this was first mentioned by Milne-Edwards, and subsequently by other authors, especially by Leydig.* The short stalk contains a canal, which appears to divide into radiating branches on reaching the "slipper," which itself is marked by a series of rings.

Among other problematical organs, I might refer to the remarkable pyriform sensory organs on the antennæ of Pleuromma,† the appendages on the second thoracic leg of Serolis, those on the maxillipeds of Eurycopa, on the metatarsus of spiders, the finger-shaped organ on the antennæ of Polydesmus, the singular pleural eye (?) of Pleuromma, and many others.

There is every reason to hope that future studies will throw much light on these interesting structures. We may, no doubt, expect much from the improvement in our microscopes, the use of new reagents, and of mechanical appliances, such as the microtome; but the ultimate atoms of which matter is composed are so infinitesimally minute, that it is difficult to foresee any manner in which we may hope for a final solution of these problems.

Loschmidt, who has since been confirmed by Stoney and Sir W. Thomson, calculates that each of the ultimate atoms of matter

* "Zeit. für wiss. Zool.," 1878.

† Brady, "On the Copepoda of the Challenger Expedition," vol. viii.

is at most $\frac{1}{500000000}$ of an inch in diameter. Under these circumstances we can not, it would seem, hope at present for any great increase of our knowledge of atoms by improvements in the microscope. With our present instruments we can perceive lines ruled on glass which are $\frac{1}{90000}$ of an inch apart. But, owing to the properties of light itself, the fringes due to interference begin to produce confusion at distances of $\frac{1}{74000}$, and in the brightest part of the spectrum, at little more than $\frac{1}{90000}$, they would make the obscurity more or less complete. If, indeed, we could use the blue rays by themselves, their waves being much shorter, the limit of possible visibility might be extended to $\frac{1}{120000}$; and, as Helmholtz has suggested, this perhaps accounts for Stinde having actually been able to obtain a photographic image of lines only $\frac{1}{100000}$ of an inch apart. This, however, would appear to be the limit, and it would seem, then, that, owing to the physical characters of light, we can scarcely hope for any great improvement so far as the mere visibility of structure is concerned, though in other respects, no doubt, much may be hoped for. At the same time Dallinger and Royston Pigott have shown that, as far as the mere presence of simple objects is concerned, bodies of even smaller dimensions can be perceived. According to the views of Helmholtz, the smallest particle that could be distinctly defined, when associated with others, is about $\frac{1}{80000}$ of an inch in diameter. Now, it has been estimated that a particle of albumen of this size contains 125,000,000 molecules. In the case of such a simple compound as water, the number would be no less than 8,000,000,000. Even then, if we could construct microscopes far more powerful than any we now possess, they could not enable us to obtain by direct vision any idea of the ultimate molecules of matter. The smallest sphere of organic matter which could be clearly defined with our most powerful microscopes may be, in reality, very complex; may be built up of many millions of molecules, and it follows that there may be an almost infinite number of structural characters in organic tissues which we can at present foresee no mode of examining.

Again, it has been shown that animals hear sounds which are beyond the range of our hearing, and that they can perceive the ultra-violet rays which are invisible to our eyes.*

Now, as every ray of homogeneous light which we can perceive at all appears to us as a distinct color, it becomes probable that these ultra-violet rays must make themselves apparent to the ants as a distinct and separate color (of which we can form no idea), but as different from the rest as red is from yellow, or green from violet. The question also arises whether white light to these insects would differ from our white light in containing this addi-

* "Ants, Bees, and Wasps."

tional color. At any rate, as few of the colors in nature are pure, but almost all arise from the combination of rays of different wave-lengths, and as in such cases the visible resultant would be composed not only of the rays we see, but of these and the ultra-violet, it would appear that the colors of objects and the general aspect of nature must present to animals a very different appearance from what it does to us.

These considerations can not but raise the reflection how different the world may—I was going to say must—appear to other animals from what it does to us. Sound is the sensation produced on us when the vibrations of the air strike on the drum of our ear. When they are few, the sound is deep; as they increase in number, it becomes shriller and shriller; but when they reach forty thousand in a second they cease to be audible. Light is the effect produced on us when waves of light strike on the eye. When four hundred millions of millions of vibrations of ether strike the retina in a second, they produce red, and as the number increases the color passes into orange, then yellow, green, blue, and violet. But between forty thousand vibrations in a second and four hundred millions of millions we have no organ of sense capable of receiving the impression. Yet between these limits any number of sensations may exist. We have five senses, and sometimes fancy that no others are possible. But it is obvious that we can not measure the infinite by our own narrow limitations.

Moreover, looking at the question from the other side, we find in animals complex organs of sense, richly supplied with nerves, but the function of which we are as yet powerless to explain. There may be fifty other senses as different from ours as sound is from sight; and even within the boundaries of our own senses there may be endless sounds which we can not hear, and colors, as different as red from green, of which we have no conception. These and a thousand other questions remain for solution. The familiar world which surrounds us may be a totally different place to other animals. To them it may be full of music which we can not hear, of color which we can not see, of sensations which we can not conceive. To place stuffed birds and beasts in glass cages, to arrange insects in cabinets, and dried plants in drawers, is merely the drudgery and preliminary of study; to watch their habits, to understand their relations to one another, to study their instincts and intelligence, to ascertain their adaptations and their relations to the forces of nature, to realize what the world appears to them—these constitute, as it seems to me at least, the true interest of natural history, and may even give us the clew to senses and perceptions of which at present we have no conception.

FOUR-HANDED SINNERS: A ZOÖLOGICAL STUDY.

By FELIX L. OSWALD, M. D.

EDMOND ABOUT used to tell a good story of a Spanish prelate who studied anatomy for the special purpose of describing the fragments of a miraculous skeleton, but who was so astounded by the discovery of a rudimentary tail-bone that he relinquished his study in dismay, and declined to specify the results of his investigation.

In a similar way the comparative study of human and animal psychology would often surprise a close observer. There was a time when the mere suggestion of such studies would have been overruled by the prevalent tenet which denied the affinity of our mental apparatus to any part of the animal organism, the attribute of "reason" being reserved for the primate of the animal kingdom, while the actions of his humble fellow-creatures were supposed to be prompted by a blind and semi-automatic agency, called "instinct." Intelligence, we were told, might be compared to a "keyed instrument, from which any music it is capable of producing may be called forth at the will of the performer," while the *modus operandi* of instinct was supposed to resemble that of a "barrel-organ, which plays with the greatest exactness a certain number of tunes that are set upon it, but can do nothing else." The mechanism of that living barrel-organ was, moreover, believed to act chiefly in the interest of the species, while reason subserved the interests and momentary caprices of individuals.

The subjective motives of that view were, however, clearly identical with the prejudice which long denied the analogies between the physical organism of men and brutes. Every step in the progress of comparative anatomy has more plainly demonstrated the fact that the alleged contrasts in the construction and the functional characteristics of human and animal bodies are mere differences of degree, and a similar conclusion must force itself upon the unprejudiced observer of animal soul-functions. Even our domestic birds often manifest symptoms of passions, whims, and moral aberrations, clearly analogous to those of their biped proprietors; and in the higher animals those manifestations become so unmistakable that a student of moral zoölogy is often tempted to indorse the view of that school-girl who defined a monkey as "a very small boy with a tail."

According to Arthur Schopenhauer's theory of moral evolution, the conscious prestige of our species first reveals itself in the emotions of headstrong volition that make a little baby stamp its feet and strike down its fists, "*commanding* violently before it could form anything like a clear conception of its own wants. . . . Untutored barbarians," he adds, "are apt to indulge in similar methods of self-assertion, and, in settling a controversy, prefer menacing gestures to rational explanations."

That tendency, however, is not confined to infants and savages. The black-faced *Cynocephalus maurus* (the "Cutch baboon" of the New York pet-dealers) resents the slightest misunderstanding of his desires, and, after reaching out for a glittering toy, can not be placated by an offered tidbit, but slams down his fist with the dogmatic emphasis of a colored revival-preacher. In his controversies with his cage-mate (a female spaniel) my pet Cutch will lay hold of the dog's tail and enforce his theories with a peremptory pull that never fails to provoke a rough-and-tumble fight; but, long after the dog has relapsed into sullen silence, her antagonist will shake the cage with resounding blows, and every now and then steal a look at the by-standers, to invite their attention to his "best method of dealing with heretics."

Egotism has been defined as the "stout stem of which altruism is the tender flower," and our Darwinian relatives can claim a healthy share of that moral substratum. *Faust-Recht,* the law of the strong hand, is the recognized code of every monkey community. Without the slightest pretext of preliminary explanations the president of a simian syndicate will snatch away the shares of the weaker stockholders and ignore the shrieks of his victims with the eupeptic equanimity of a retired railway nabob. The mere sight of alien property is apt to excite the covetousness of a privileged four-hander. My pig-tail monkey (*Macacus nemestrinus*) can not see a dog gnaw a bone without plotting the appropriation of the unknown dainty, and, even after a series of vain attempts to utilize his booty, will guard his prize in the vague hope of discovering the secret of its value. He sleeps in a tub, but has failed to adopt the cynic tenet of attaining happiness by a reduction of his desires; and whenever he succeeds in pulling the staple of his chain, his barrel gets stuffed with an accumulation of miscellaneous plunder, including such objects of rather limited utility as kite-tails, empty bottles, ice-hooks, feathers, and potsherds. He is fond of taking an inventory of his property by spreading his collection on an open porch, but at such moments regards every intruder with nervous suspicion, and at the approach of a street Arab makes a determined rush to obviate a possible depreciation of his stock.

The acquisitive energy of a monkey-swarm must be witnessed to be credited. In the banana-gardens of the *tierra caliente* a Mexican capuchin monkey will exhaust his business opportunities with the dispatch of a Cincinnati bank-cashier; but, in his attempt to reach the Canadian side of the hedge with a good armful of plunder, so often falls a victim to the pursuing dogs that monkey-trappers frequently rent an orchard for the special purpose of capturing the retreating marauders.

An equally effective method is that of the Abyssinian pet-hunters, who decoy baboons by imitating the squeal of their youngsters. In spite of their mischievous petulance, nearly all the Old World species of our four-handed kinsmen are emotionally sympathetic, and ever ready to rescue their wounded friends at the risk of their own lives. At the cry of a captured baby-baboon, the whole tribe of passionate four-fisters will rush in, regardless of consequences, and a similar tendency of co-operation may have given our hairy forefathers a superior chance of survival and secured their victory in their struggle for existence against their feline rivals. Their list of original sins may have included gluttony, covetousness, and violence of temper, but hardly a *penchant* for wanton bloodshed. With the exception of the fox-headed lemurs and the ultra-stupid marmosets, nearly all our simian relatives evince symptoms of a character-trait which might be defined as an instinctive aversion to cruelty. Menagerie monkeys indulge their love of gymnastics by frequent scuffles; but the sight of a *bona-fide* fight awakens a chorus of shrieks expressing a general protest rather than an emotion of fear or even of partisan interest, for in an open arena the stouter members of the obstreperous community are sure to rush in and part the combatants. That result, at least, forms a frequent *intermezzo* of the circus-fights at the capital of Baroda (British India), where the sport-loving prince pits all sorts of beasts and birds in single combat, and often diversifies the proceedings by introducing an able-bodied ape.

Like Buddha Sakyamuni, my Cutch baboon extends his compassion to all suffering fellow-creatures. Orphaned kittens or whining puppies straying within reach of his arm risk their lives in his sympathetic embraces. He will hug even crippled rabbits and half-drowned rats, and in his anxiety to relieve their ailments will often resort to the expedient of instituting an entomological inquest, searching their hides for vermin as a possible cause of their distress. One of his temporary playmates, a pot-bellied young Chacma baboon, aggravated his unpopularity by an incurable *penchant* for peculation; but the occasional penalties of his misdeeds were more than outweighed by the demonstrative sympathy of his kinsman, who would snatch up the squealing little monster and coddle him for hours, every now and then voicing his protest against human methods of discipline in a shrill scream, which his young *protégé* never failed to accompany with an approbative grunt.

In Hindostan, where three varieties of sacred monkeys enjoy the freedom of every town, those four-handed pensioners often assist the police in enforcing the riot-laws by charging *en masse* for the scene of every dog-fight and school-boy scuffle. They will rescue worried cats, and, for greater security, deposit them on the next roof, or suppress rowdyism in general, the stout Rhesus baboon, for instance, being physically as well as morally qualified to quell the aggressive disposition of the fiercest cur. On the platform of a public warehouse the British residents of Agra, a few years ago, witnessed a scene which put that character-trait in even a stronger light. A little street Arab had spread his pallet in the shade of a stack of country produce, and had just dropped asleep, when the proprietor of the Planters' Hotel strolled up with a pet leopard that had learned to accompany him in all his rambles. A troop of tramp monkeys had taken post on the opposite end of the shed, and, like the beggar boy, seemed to enjoy a comfortable *siesta*, but at sight of the speckled intruder the whole gang charged along the platform like a squadron of *spahis*, and, instantly forming a semicircle about the little sleeper, faced the leopard with bristling manes, evidently resolved to defeat the suspected purpose of his visit.

Our four-handed cousins apparently credit their biped kinsmen with reciprocative tendencies. Three years ago a New York pet-dealer shipped me a bonnet-macaque to Tallulah, Ga., where my guest happened to arrive during the temporary absence of the regular express agent. His assistants, in trying to feed the interesting stranger, managed to break the top of the box, and, after taking to their heels, made matters worse by attacking the deserter with stones and brickbats, till he evaded their missiles on the turrets of a three-story hotel. Here a literal "*steeple*-chase" was kept up for hours, with the co-operation of an ever-increasing number of volunteers, till the approach of night obliged me to adopt the plan of a veteran squirrel-hunter, who offered to recapture the fugitive by a "crease-shot"—i. e., to cripple him just enough to compel his surrender. The expedient led to the desired result; but from that day our prisoner behaved like a captive wild cat, bristling up at the approach of every visitor, and wearing out his teeth in a series of desperate attempts to break his wire chain. By dint of perseverance he at last effected his purpose, and once more enacted a declaration of independence; but this time fate was too close on his heels, and, before he had run more than a hundred yards, the dogs obliged him to take refuge in the top of a small pine-bush. On my arrival the leader of his pursuers, a big deer-hound, was assailing that bush with leaps that speedily threatened to make the hostile position untenable, and was just bracing himself for another spring, when the deserter suddenly leaped upon my shoulder, and, clasping my neck with both arms, invoked my protection in a mumble so expressive and persistent that I had to gratify him by stampeding the dogs.

In the art of gaining allies in a perilous emergency, our four-handed cousins can, indeed, rival the tricks of a Turkish diplomat. Whenever my little Chacma incurred the displeasure of his big relative, he would make common cause with the spaniel by patting his back and expurgating his fur with feverish haste, and, at the approach of the vindictive Cutch, often managed to push his ally to the front and make him stand the brunt of the inevitable scuffle; and when my negro boy-of-all-work once caught him on the top shelf of a cupboard, he at once made a rush for the lap of an incidental visitor, and with screams and excited gestures urged him to treat the young African as a common enemy.

A less pleasant character-trait was his tendency to vent his resentments on impartial by-standers. His morbid passion for chewing-tobacco often induced him to pick the pockets of my mail-carrier, and, after the consequent spanking, he repeatedly sneaked up on the porch to "take it out" of an old tabby who made the corner of the veranda her favorite roost and submitted to such outrages with the patience of a poor servant-girl bearing the vicarious brunt of a family squabble. A similar display of spite often makes existence a burden to the cage-companions of a Hanuman ape, a chief saint of the zoölogical pantheon of Brahmanism. In Hindostan the undisputed prestige of that eupeptic demigod secures him a constant surfeit of tidbits, and in Western menageries the lack of appreciation and cream-pies often provokes him to snub his secular fellow-captives with the vindictive arrogance of an exiled abbot.

In the semi-human apes the concupiscent curiosity of the genus often takes the form of abstract inquisitiveness—the root of all heresies. A young chimpanzee, that accompanied me on my last return trip from Antwerp, would examine the construction of a padlock with the interest of an amateur mechanic, and once passed a whole hour in the vain endeavor to solve the enigma of a baby-rattle—a perforated shell inclosing a number of metal pellets. After scrutinizing the marvel from all possible points of view, he made a cautious attempt to open the shell with his teeth, but the reprimand of a spectator at once made him relinquish that plan. He then deposited the shell on a rug, and, turning it over and over, frequently stopped to listen, as if comparing the results of his various experiments. My Cutch baboon, too, will examine a picture-book, page for page, and occasionally use his fingers to verify the impression of a striking illustration—an expedient which apparently fails to dispel the illusion of a looking-glass, for, after the experience of a hundred *séances*, he still persists in making a grab at the empty air *behind* the frame, in the obstinate hope of corroborating the material existence of his *Doppelgänger*. After thoroughly familiarizing himself with the contents of my sitting-room, he has ceased to overhaul my shelves; but the introduction of any novel object at once re-excites his curiosity, and for similar reasons the wary four-handers of the South American tropics promptly emerge from their hiding-places at sight of a speckled dog—a zoölogical phenomenon too wondrous to be ignored from motives of discretion. An unfamiliar sound, the tinkling of a cow-bell in a new clearing, or the whirr of a buzz-saw, is equally sure to attract the attention of the four-handed aborigines. They will pursue the strolling bell-ringer for miles, and often stop to compare notes in a sort of solemn whisper.

But that scientific enthusiasm of our tree-climbing cousins is apt to be dampened by the first drop of night-dew. In daytime the restless vigilance of the tree-man enables him to hold his own against his wiliest foes; but after sunset the owl-eyes of the prowling *Felidæ* give them a fatal advantage, and the instinct of *night-fear* may thus deeply, and perhaps indelibly, have impressed itself upon the mental organism of our forefathers. A petted four-hander of the bolder species, the East Indian Rhesus, for instance, will contract a habit of pursuing his *penchant* of free inquiry to any length, even through the door of a shooting-gallery, which he will push wide open to ascertain the cause of the abnormal detonations; but after dark the same investigator will flee from the rustle of a dry leaf, and watch the shadow of a fluttering curtain with the rapt expectancy of a second adventist.

Inveterate habits persist. The progress of evolution has changed our spooks from hairy bugbears into soft-handed familiars, and may yet change them into kid-gloved exquisites; but, with or without claws, ghosts will probably continue to appear after sunset.

SKETCH OF EDWARD ATKINSON.

THE subject of the present sketch holds a prominent position among American writers who have made most valuable contributions to political and economic science. His essays, all in this or related departments, are characterized by far-reaching grasp of thought, boldness and absolute independence in discussion, and the clear and direct manner in which the principle he is seeking to develop is presented.

Edward Atkinson was born in Brookline, Mass., February 10, 1827. Having fitted for college, it became expedient for him to go to work at an early age, and he served his time, after August

8, 1842, in a commission-house for the sale of domestic cotton goods. In 1848 he entered the service of manufacturing companies, and from that date until 1878 was engaged as treasurer or manager of factory corporations. In 1878 he became President of the Boston Manufacturers' Mutual Fire-Insurance Company, and has since devoted his time largely to the study of the prevention of fire in factories.

In one of his essays he says that he first began to think in the Free-Soil campaign of 1848; that he then despised statistics, and was under the profound conviction that every advocate of free trade had a cloven foot. He held to these opinions until about the beginning of the war. Being prevented from entering the service by home duties, he devoted himself to the study of the resources of the United States, and from the study of facts rather than of books, and from his long experience, he became an advocate of hard money, opposed to the Legal-Tender Act, and in 1866 he also became a convert to free trade, subject in its application to such consideration as might rightly be given to branches of industry whose course had been somewhat altered by the long continuance of the protective system.

Besides his studies in economic science, and above them, according to his own estimation, Mr. Atkinson is the inventor of a form of cooking apparatus by which the process of preparing food is greatly facilitated, while the quality of the product is certain to be improved. It comprises two ovens, one heated by a column of water, the other heated by a column of air, the heat being derived from common kerosene-oil lamps so arranged that the products of the combustion of the oil can not touch the food. Having baked twenty pounds of bread in one oven with one cent's worth of oil, and being able either to simmer in one vessel or to roast in the hot-air oven thirty pounds of meat at a cost of not exceeding two cents' worth of oil, he believes that he has accomplished economy in domestic cookery in a way which Count Rumford attempted but failed to make popular, but which might become the common practice of all, now that kerosene-oil yields a cheap source of heat. These inventions are not patented, but are purposely left open for public use.

By his connection with an association of New England mill-owners, for prevention of fires in their factories and for insurance, he has been instrumental in raising the profession of underwriter from a mere system of betting on the chances of loss by fire on property, as it may happen to be at any given time, to one in which science shall be applied at every point, both in the construction and occupation of buildings, and to the prevention of such losses, under the direction and instruction of capable officers of insurance companies, who will consider every loss by fire an obnoxious incident for which some person, generally the owner or occupant, shall be held responsible.

From the fruits of his studies in economic science he has sustained, or perhaps first presented, the proposition that the burden of a tax upon any commodity can be truly measured only by its ratio to the margin of profits on a given manufacture rather than by its ratio to the total cost of the product into which the taxed material enters as a component. Hence a tax bearing a very small ratio to the gross value of the product, when imposed upon some apparently insignificant article which enters into a process of manufacture, may entirely forbid the establishment of that branch of industry in a country where otherwise it might have been successfully established. He therefore opposes duties on what are commonly but incorrectly called "raw materials," for the reason that such duties, when imposed upon crude or partly manufactured materials which are used in the various processes of domestic industry, not only cripple the manufacturers, but also injure the domestic producers, even of the same materials, by restricting their use.

He has, further, worked out and presented facts in proof of the theory that the wages or earnings of those who are commonly called "*the working-classes*" are a result of production, and can not be considered an antecedent to production which can be absolutely measured and determined or agreed upon for any considerable period before the work is undertaken, since all taxes, profits, and wages must, in the long run, be derived from the product itself. It follows, however, from this principle that, under free conditions, high wages in money, or in what money will buy, must in the end be the necessary correlative or consequence of a low cost of production. In other words, the price of labor does not measure the cost of labor, the cost of labor depending upon many other elements than the wages or earnings of those who take part in the conversion of the cruder products of the soil, the mine, or the forest, into the finished forms commonly known as manufactures.

He has also maintained the proposition that under free conditions of exchange the workman must of necessity, decade by decade, secure to his own use or enjoyment an increasing share of an increasing product, even though free exchange be limited in the United States to its own area—the exceptions to this rule being in countries where the free exchange of services is obstructed by the diversion of products in the form of taxes to the support of great standing armies, or to the payment of interest on huge national debts. In such instances, the benefits of improvement and invention being taken up by the tax-gatherer, it may follow that the workman is, decade by decade, becoming poorer and more incapable of sustaining himself in comfort and welfare. This conclusion—that labor receives a constantly increasing share of an increasing product, and that capital receives a diminishing share of an increasing product—which Mr. Atkinson has demonstrated, is one of the most encouraging facts that have been discovered in the progress of modern civilization. It tends to show, what we now know to be the fact, that there is a gradual equalization in the distribution of property, and that a larger number of persons in this age possess a competence than in any other period of the history of the race.

The proposition that the burden of a tax upon any commodity is measured by its ratio to the margin of profit rather than to the entire cost of the product, is vigorously presented in an article on "The Visible and Invisible in Protection," which was published in the "Atlantic Monthly" for February, 1872. Its truth is even more evident in the condition of our country to-day than it was at that time. Classifying commodities subject to taxation, as those which are of necessary use in processes of domestic production, and those which are of voluntary use on the part of the consumer, the paper lays down the principle that, "in accordance with the rule that it is fit to take, under the necessity of taxation, a small portion of the luxury or even the comforts which men seek as the end of their labor, rather than to impair their means of subsistence, taxes should not be imposed upon articles of the first class, but may be imposed upon those of the second class." The effect is then considered of the taxes then and now imposed upon articles of the first class in their relation to profits, and is gauged by comparison with an imaginary tax upon an article in universal use on which no tax would be tolerated, if it were imposed. Such an article is milk, with its products, butter and cheese. Suppose their price were increased by the imposition of a tax of fifty per cent. "There would surely be controversy, bitter discussion, and perhaps violent resistance, should such a tax be imposed; and yet the general cost of subsistence would be no more increased, while the power of enlarged production would be far less restricted and hampered, by a tax of fifty per cent upon dairy products, than they are now by the tariff taxes imposed on foreign imports of crude or partially manufactured materials. Nor would the burden be distributed more widely. The use of dairy products is no more universal or necessary than the use of the articles of foreign import named in our list" (including a number of articles of the first class); "and there is almost as much luxurious consumption of dairy products as there is of foreign imports. It may be asserted, without fear of contradiction, that all these articles imported from other countries are as much the product of American labor as the dairy product, or as if they had been raised upon American soil by the hands of native-born men and women, since every one of them has been or must be paid for by an exchange of some domestic product for it, whether it be cotton, oil, gold, cheese, or wooden clocks; and the only reason why this exchange is ever made is that we have too much of the things made upon our own soil, and too little or none at all of those things of foreign origin for which we make the exchange. Production is but a *leading forth;* it is but movement. We move the cotton-seed to the soil, the cotton to the Northern mill, the cloth to the seaboard; then, by the steamship, we move it to where it is more needed than by ourselves; we move back the tea, and the tea is but the final product of the labor of the freedman, the operative, and the sailor, each of whom is or may be our countryman, and each of whom is counted as a representative of home industry. . . .

"We once established the manufacture of furniture, so that our mechanics, working at from $2.50 to $3 per day, yet supplied many foreign customers; but we have taxed the wood, the varnish, the oil, the paint, the tools, the food, and the fuel of these men forty per cent on all those portions which are of foreign origin, and thus they have lost their customers. Privation of imports is prohibition of exports. Protection to the mechanic is to be found only in the repeal of bad taxes."

The far-reaching nature of the evil of wrongful taxation is illustrated in the case of the taxation of tin plates, for which revenue the Government has no use whatever, but by the operation of which "we leave England and France to supply the world with canned meats and fruits, while we only put up enough for our own use." This result is brought about by the tax adding to the cost of the domestic product into which the tin enters as a constituent element; "and if this increase amounts to only two or three per cent of the value of the finished product, it amounts, as we have proved, to a tax on the income of capital of from two or three up to ten or twenty per cent. Hence, foreign capital takes the business, and home labor ceases to be employed; diversity of employment is prevented; wages are lowered, and the cost of subsistence increased; and all this is done in the name of protection to labor!"

The visible in protection—what one sees, "is that we prosper in spite of all the privations inflicted under due process of law; such are the boundless resources with which the Almighty has endowed this land." The invisible, what one does not see, "is the far greater prosperity which we might have, except for the ignorance of those who make these unjust laws, and in the name of protection inflict privation. What one does not see is the progress in the arts of peace and good-will with all nations which might ensue if we did but realize that the ships that pass between this land and that are like the shuttle of a loom, weaving the web of concord among the nations, and that commerce is the most potent agent of civilization."

Mr. Atkinson is what is called a self-educated man, but he accepts the comment made by Dr. Francis Lieber on this phrase, that one might as rightly speak of a self-laid egg. What both gentlemen mean by this *dictum* doubtless is that men are inevitably the creatures of the conditions among which they are placed, over which they have no control. But, as it is usually applied, the expression "a self-made man" means no more than that his character and faculties have been developed independently of the artificial aid of schools and book-lore, by hard contact with the world and the experiences of active life; and Mr. Atkinson would hardly deny that he is a man of that kind. What he is, in character and modes of thought, is in the main the product of a life spent in the factory and counting-house, combined with habits of close, independent observation. A clew as to the turn which his seeking takes when knowledge is to be acquired, may be gained from the opening sentences of his paper on "Kentucky Farms," in "Harper's Magazine" for June, 1881: "Whenever a business man gets away from his affairs, and journeys into a far country for even a short time, he may see many things that he would entirely overlook if, with his mind filled with the everyday cares of life, he passed through the very same sections in the usual unobservant way. A pity it is that our commercial travelers could not become trained observers, ready and acute as they are in all that pertains to their work, often witty and full of good stories. If they could learn to spend the many hours which they are obliged to pass wearily in country taverns that are none of the best, and are often of the worst, in reporting what they might observe, what a resource against weariness it would be for them, and what a benefit to all who wish to know what the resources of this country really are, and how they could be developed! The business man who can write at all writes best for other business men." To this habit of sharply observing for himself, Mr. Atkinson adds, as he goes on to relate, what he calls a patent method of his own. He goes to persons—as for instance, in this case the State geologist, in studying the resources of Kentucky—who have special knowledge of the subject in hand, and becomes, for the time being, their student. By such means he has accumulated a vast fund of information about the resources of the United States, and the condition of the different parts of the country, which, having made himself familiar with the subject in hand, he can use with telling effect whenever he has a condition to account for, or a lesson to draw indicating a line of policy. His journey to Kentucky was made to obtain information about the homespun fabrics that are made and worn by the people of the mountain-regions of that and the adjoining States. In a discussion concerning the conditions of transporting flour from Minneapolis to Europe, he acknowledges indebtedness to twenty-six distinct sources whence he obtained information, including railroad presidents, manufacturers, editors of special journals, Government officers, and managers of land-mortgage companies. The purpose of the discussion just named was to prove that it was possible to supply the European markets with breadstuffs at a very low cost, and at the same time secure high earnings to farm-laborers, coupled with reasonable profits to the farmers, millers, and transportation companies. Having shown that the wages of one day's work of a good mechanic on the Eastern seaboard of the United States will suffice to move his year's supply of grain and meat one thousand miles from the Western prairie, while the skilled workman of Great Britain may also move his year's supply of grain and meat four or five thousand miles at a cost of two days' labor, possibly three, he adds: "Have not the scientists who have eliminated time and distance made the whole world one great neighborhood in which each man may serve his neighbor? But the masters of physical science have only removed natural obstructions. There is work now for the masters of political science. It now remains for Legislatures to remove the artificial obstructions created by their predecessors in order that each nation may serve the other. When that is done, the interdependence of the men of all countries and of all climes will be established, and the foundation of peace, order, industry, good-will, and plenty among all nations will be firmly laid."

Such is the destiny to which Mr. Atkinson, despising the petty devices and make-shifts of politics, and looking only to what will contribute most directly to the ultimate result, would lead us.

Mr. Atkinson is a member of the American Academy of Arts and Sciences, of the British Association, Fellow of the American Association for the Advancement of Science, of the American Statistical Association, of the Political Economy Club, of the International Statistical Institute, of the Cobden Club, and several other bodies of like kind. He has never held any public office except when commissioned by the President in 1887 to report upon the status of bimetallism in Europe. He has always been an independent in politics.

The various papers which have been written by Mr. Atkinson are constantly referred to in economic discussions by persons who differ with each other and who do not accept his conclusions, his analyses of the facts of the economic life of the nation being accepted even by those who do not agree with his theories.

His papers on the industrial development of this country, especially during the last twenty-five years, are cited by the advocates of both policies in the present tariff controversy. Their ability and fairness of statement are fully admitted. Mr. Atkinson himself believes that the tariff question is one of the minor factors in the industrial history of this country; that its influence in promoting certain branches of industry has been much exaggerated on the one side, and that its burden upon consumers has been as much exaggerated upon the other. He rejects alike the theory of the extreme advocate of protection, that diversity of occupation has been promoted by means of the protective system; and, on the other hand, he rejects the theory of the extreme free-trader that an enormous bounty has been paid to or gained by special industries, merely because a duty has been imposed upon a foreign import of like kind. He holds that while manufactures would be established in greater variety, and would attain ultimately much greater prosperity, if free exchange could be attained by a cautious and systematic reform, on the other hand, the market for the excess of the crude products of our soil, as well as for our manufactures, might be vastly extended by such reform—to the end that the United States would attain a commanding position in the commerce of the world, even to the extent of possibly compelling European nations to disarm. Keeping in view the proposition that profits, wages, and taxes are alike derived from the joint product of labor and capital, he presents the simple formula that "a nation free from debt, subjected to the lowest rate of taxation of any nation in the world, and without the need of withdrawing from productive labor an enormous number of men to be enlisted in a standing army or navy, and finally endowed with greater natural resources than any other country in proportion to the population, must be able to compass a larger product at less cost than can be attained in any other of the so-called manufacturing countries." He therefore advocates a gradual but sure reform of the abuses which exist in the present acts for collecting the national revenue, to be brought about with due regard to the present condition which many branches of manufacture have reached during the long period in which a high tariff has been in force."

Mr. Atkinson's essays, nearly all upon subjects of political economy, have been published at various times since 1861 in independent pamphlets, the reports of economical associations, and periodicals of general circulation, such as the "Atlantic Monthly," "Scribner's Magazine," "The Century," "Harper's Magazine," and the "North American" and "International Reviews." The full list numbers more than forty titles, including the following: "Cheap Cotton by Free Labor," 1861; "Is Cotton our King?" 1862; "The

Future Supply of Cotton," 1864; "The Collection of Revenue," 1866; "Free Trade and Revenue Reform," 1871; "The Visible and Invisible in Protection," 1872; "An Easy Lesson in Money and Banking," 1874; "Argument for the Conditional Reform of the Legal-Tender Act," 1874; "Commercial Development in the First Century of the Republic," 1876; "Industrial Reconstruction," 1878; "Our National Domain" (chart), 1879; "American View of American Competition" (London), 1879; "Labor and Capital Allies, not Enemies," 1880; "The Fire-Engineer, the Architect, and the Underwriter," 1880; "The Railroads of the United States," 1880; "The Unlearned Professions," 1880; "Address on Banking," 1880; "A Reply to Prof. Bonamy Price," 1880; "Cotton Manufactures of the United States," 1880; "Addresses at Atlanta, Ga., at the International Cotton Exposition," 1880, 1881; "What is a Bank?" 1881; "Elementary Instruction in the Mechanic Arts," 1881; "Address at the Annual Banquet of the Massachusetts Charitable Association," 1881; "What makes the Rate of Interest?" 1881; Address on the Right Method of preventing Fires in Mills," 1881; "The Solid South," 1881; "The Railway and the Farmer," 1881; "Kentucky Farms," 1881; "The Influence of Boston Capital upon Manufactures," 1882; "Significant Aspects of the Atlanta Exposition," 1882; "The Rapid Spread of Communism," 1882; "Address at the Opening of the Manufacturers' and Mechanics' Institute Fair," 1882; "Inefficiency of Economic Legislation," 1882; "What makes the Rate of Wages?" 1884; "Address to the Chiefs of the Bureau of Labor Statistics," 1885; "The Distribution of Products," 1885; "On the Application of Science to the Production and Consumption of Food," 1885; "Prevention of "Loss by Fire," 1885; "The Hours of Labor," 1885; "Address on the Silver Question," 1886; a series of monographs (in "Bradstreet's") on economic questions; a series of articles (in "The Century") on "Food and Wages"; "The Margin of Profits," 1887; "Report on Bimetallism in Europe," 1888; a series of articles in "The Forum," 1888. Of these papers, the address at Atlanta, in 1880, was characterized by Judge E. R. Hoar as marking an "era in the history of the country"; and the book on the "Distribution of Products" was pronounced by Sir Louis Mallet "epoch-making."

It has been advanced as a weak point in the theory that man has received his qualities by inheritance from the other races, that when men manifest extraordinary qualities they are such as are entirely different from those possessed by any other creature, and peculiar. Human prodigies excel, not in the development of animal traits and instincts, but as wonderful calculators, great moral geniuses, or phenomenal musicians. The most wonderful instincts of the lower creatures appear to be extinguished by the advance of reason, instead of being stimulated by it; and men who transcend humanity do so not in the respects in which they have inherited most, but in those in which they have inherited least.

CORRESPONDENCE.

DOCTORS AND THE OPIUM-HABIT.

Editor Popular Science Monthly:

IN the September number of "The Popular Science Monthly," Mr. Virgil G. Eaton makes the following statement in his article on "How the Opium-Habit is acquired": "The parties who are responsible for the increase of the habit are the physicians who give the prescriptions. . . . Opium effects immediate relief, and the doctors, knowing this, and wishing to stand well with their patients, prescribe it more and more. Their design is to effect a cure. The result is to convert their patients into opium-slaves. The doctors are to blame for so large a consumption of opium, and they are the men who need reforming" (p. 666). While there may be exceptional cases where physicians are responsible for a patient acquiring the opium-habit, this charge against the entire medical profession is unjust and misleading. No class of men is better acquainted with the dangers due to a prolonged use of opiates than the medical practitioners, but it does not follow that a knowledge of the fact should lead any one of them to abandon the use of this valuable anodyne in suitable cases. No physician will question Mr. Eaton's statement that opiates are prescribed very frequently. If Mr. Eaton had taken the trouble to inquire from physicians why this is so, he would probably have ascertained that a large number of patients suffer considerably during their sickness, and that, to alleviate these sufferings, and give the patients the best chances for recovering their health, opiates are often prescribed, and not merely because the physician wants to "stand well with his patient," or even to "effect a *cure*." Surely, no honest practitioner would be brutal enough to withhold an anodyne to relieve the intense pain due to a "stone in the gall-duct" (and if it were in Mr. Eaton's personal gall-duct), provided the anodyne caused no other serious injury. In this case the anodyne is not given to "effect a cure," but to permit the passage of the stone through the duct with less pain to the proprietor of the duct than were possible without the drug.

While putting the responsibility for the opium-habit on the physicians, Mr. Eaton says (p. 665), "From a conversation with a druggist, I learned that the proprietary or 'patent' medicines which have the largest sales were those containing opiates." While Mr. Eaton's article proves his knowledge of the practice of medicine to be very limited, he can hardly be ignorant of the fact that the members of the medical profession have been and are to this day warning their patients and the public against the use of all nostrums. This is done by physicians, not for selfish purposes, as Mr. Eaton probably thinks, but because they have some thought for the health and well-being of their patients.

Immediately after telling us that the doctors are the men who need reforming, Mr. Eaton gives us two means for preventing the opium-habit. Here we find that he does not mention the method of reformation, but recommends that the renewal of prescribed medicines containing opiates, without the consent of the physician, be prohibited. Now this is a very good recommendation, but, as "there is nothing new under the sun," so this suggestion is not original. A perusal of medical literature would demonstrate that the medical profession, as individuals, and through their associations, have for years past protested and advised against renewing prescribed medicines without the physician's consent. They would not, however, have it limited to opiates, but have it apply to all medicines, for very good and not solely selfish reasons. After such good advice from Mr. Eaton, it is a great disappointment to find in the second and last suggestion that again no method of reforming the doctors is given, but here he mentions the very good but not always practical preventive for the opium-habit is not to get sick. True, Mr. Eaton does not put it in these words, but it is practically the same as to say: "Avoid sickness by living according to the laws of health. If you are not sick, you will not require medicine; and if you don't take medicine, you will not become a victim of the opium-habit."

After so clearly showing that "patent" medicines, and the druggists, who so willingly refill prescriptions, are to a very great degree responsible for the alarming increase of the opium-habit, Mr. Eaton's charges against the physicians are entirely out of place.

A. F. STIFEL.

WHEELING, W. VA., *August*, 29, 1888.

OUR ASTRONOMY CLASS.

Editor Popular Science Monthly:

IN Chapter IX of "Prince Otto," by Robert Louis Stevenson, better known to fame as the author of "Dr. Jekyll and Mr. Hyde," the hero goes to an appointment with the countess, "as the bell beats *two*" in the morning. At this hour, we are told, "a shaving of *new moon* had lately arisen; but was still too small and too low down in heaven to contend with the immense host of lesser luminaries, and the rough face of the earth was drenched with starlight."

The object of this communication is to nominate Mr. Stevenson for membership in that "infant class in astronomy" to which you have already assigned H. Rider Haggard, Anna Bowman Dodd, Andrew Lang, Edward King, and Tolstoi. J. Boulware Kidd.

Richmond, Va., *August*, 19, 1888.

CALIFORNIAN PERFORATED STONES.

Editor Popular Science Monthly:

I think your correspondent is in error concerning the uses of the perforated stones of California.* I never heard of any one of those uses before, and all of them seem improbable.

1. I have seen the squaws digging roots, and never knew of their carrying a five-pound stone around, when their own body furnishes one hundred and fifty pounds, as a "digging weight." In their line of business they are no fools.

2. Each arrow and spear of the Indians represents hours of patient labor, and any one acquainted with them knows how averse they are to expending them upon any mark other than game, much less upon rocks. One of these stones, now in my possession, has the eye-hole much out of the center, and who can determine the line that hole would describe when the stone is rolled along on the ground? Further, the Diggers were and are averse to any games that do not allow them to sit lovingly and lazily upon the bosom of Mother Earth.

3. Pipes and pestles are the only "cylindrical objects" I know of among the Indians, and none of these are small enough to go through the eye-hole. It shows no evidence of having been used as a die; and those objects show no evidence of having been made by a die.

Now, as to their real uses. The specimen of which I send you an outline is a fair sample of most of them. Weight, four and a half pounds. The eye-hole is countersunk on both sides, coming to an edge in the center, but more sloping on the right, fitting the thumb of the right hand, whichever side was grasped, as both sides are very nearly alike.

1. Indians tell me that they were used for pounding acorns and other nuts fine enough to be afterward ground on the *metate* for making bread.

2. They were used for heating water and cooking in baskets; a stick run through the eye-hole of the hot stone prevents it from sinking to the bottom and burning a hole through the basket. I once saw the Indians cooking in a basket, but not with these stones. The basket stands near the fire, and with half a dozen hot stones constantly being changed they will have the water boiling much quicker than it can be done on a stove.

* "Popular Science Monthly" for August, p. 569.

The above information I get from the Indians, and it accords with the probabilities and other evidences.

I inclose an outline of another stone which for a long time puzzled me. It is a flat cog-wheel one and a half inch thick. Four of them were plowed up in an Indian camp, the only ones I ever saw. An old Indian the other day instantly placed the palm of his hand flatly over the disk, and, with his fingers among the cogs, made motions as with a hammer, and said it was used for cracking *piñones*. The *piñone* is the nut of a certain pine-tree, of which the Indians used to gather large quantities for winter use. Yours truly,

Franklin Cogswell.

Pomona, Los Angeles Co., Cal., *August*, 14, 1888.

CAN ANIMALS COUNT THE DAYS?

Editor Popular Science Monthly:

In looking over back numbers of "The Popular Science Monthly," an article in the issue for June, 1886, entitled "What may Animals be taught?" attracted attention. In the early part of the paper an instance of animal intelligence is quoted, and remarks thereon made by the author which, to the thinking of many, rob our "inferior brethren" of credit justly their due, and of faculties evidently their own. The instance is as follows: "M. Dubuc speaks of a pointer which had learned, after a few years, that its master went hunting every Sunday, and therefore that the animal had learned to count up to seven." The author of the article says: "This conclusion is not legitimate; it may even be said to be wrong. The dog distinguished Sunday by some features peculiar to it, by the movements about the house, the behavior and Sunday dress of the servants, the dress of the master, or any one or more of a number of things that make Sunday different from other days of the week; but we may say without contradiction that it did not count seven."

Nevertheless, facts do, to all appearance, contradict that dogmatic assertion. For myself, I can not see why the conclusion is denied that animals, as they come to apprehend the advent of Sunday, have some way of keeping count of the seven days of the week. The following fact bears directly upon that point: Something like half a century ago, the writer had the care and milking of five cows during one summer. They grazed in a pasture-lot many rods from the dwelling. It was the custom to give the animals salt every Sunday morning. They enjoyed the treat, and it was evident that they began to expect it. After a length of time—I can not say how long—a curious behavior of the cattle became conspicuous, for every Sunday morning they were found standing at the bars, the point nearest the house, with every appearance of mute expectation. At every other morning, as well as at evening, they had to be sought and brought to the bars for milking. Sometimes I would forget to take the salt with me at the stated time, when, instead of moving off to feed after my task was done, as they usually did, they remained about the spot an hour or so, as if waiting for their weekly rations of salt.

Here, then, is the problem: Every Sunday morning these cows came of their own option to the place of milking, and where on that day they generally got salt, and not on other mornings. How could they do that, except through some faculty of estimating the seven days of the week? If "the dog distinguished Sunday by some features that were peculiar to it," we can not say the same of the cows in question. They were isolated from the outer world, away from any thoroughfare, and saw no one but myself from one week to another and from one month to another. So far as we can judge, one day was like all days excepting Sunday, which they might have called *salt-day*, had they possessed the faculty of speech. How did they note that cycle of time, to be there on that morning and not on any other morning?

A. S. Hudson, M. D.

Stockton, Cal., *September* 1, 1888.

EDITOR'S TABLE.

THE MORALITY OF THE FUTURE.

ONE of the most interesting papers read at the recent meeting of the American Association for the Advancement of Science was one upon "Altruism considered economically," by the Vice-President of the Section of Economic Sciences, Mr. Charles W. Smiley. The drift of Mr. Smiley's address, which may be read in our present number, was to the effect that the impulse to do good to others at the cost of sacrifice to one's self was one that required careful watching and discipline, as otherwise it would be very likely to prove more harmful than beneficial. The more we study the operation of the fundamental laws of nature, the more clearly we see how essential they are to all healthy living; and how little upon the whole is gained, and how much is lost, in the effort to transcend them in the name of higher principles. Thus, self-preservation is the first law of all animated life; but some have thought it worthy only of the brute creation, and have preached in its stead the law of self-sacrifice. Doubtless, as Mr. Smiley admits, there have been times in the history of the world when there was pressing need for the preaching of self-sacrifice as a corrective to the selfish and unscrupulous pursuit of personal ends; but the time has now come in our modern civilized communities when it should be seen that the highest service any man can render to the community is not to devote all his goods to feed the poor, or perform any other signal act of self-denial, but to practice justice and labor to strengthen the characters of those around him. Self-sacrifice as a principle is wanting in logic, seeing that it implies the gain of one through the loss of another. We have had in the past, and still have, numerous institutions that have sprung from the idea of self-sacrifice; and, with a large portion of the community, it is a fixed idea that only acts involving self-sacrifice can have any merit. But experience is showing more and more that those who are supposed to stand in need of all this voluntary benevolence derive but little real advantage from it; that, on the contrary, it further weakens their already defective characters, and tends to make their condition one of chronic and constitutional dependence on the assistance of others.

How is it, we may ask, that, in spite of all that is done for the poor in the way of charity, the demand for charity is annually greater and more pressing? The object of giving help ought to be to raise the recipient above the need of help; but this result is manifestly not being accomplished. For one charitable fund that existed a generation ago there exist at least five to-day; and almost every week something new is started, looking to the removal, by force of charity, of this or that form of social misery. Every now and then some agent of this charitable work makes a confession as to its very general inutility; indeed, parodoxical as it may seem, none know so well how little charity in any form can do for the poor as those who are foremost in charitable efforts, or most immediately concerned with the actual distribution of help. It is undeniable that, just in proportion as the liberality of the charitably disposed increases, the demands upon it increase, and that, conversely, with the cessation of alms-giving, the need for it seems to vanish. There are facts to illustrate both points. We have seen it stated lately in the Boston papers that the abounding charities of that city have drawn to it people who consider themselves objects of charity from all the surrounding country; and, if so, we can judge what the effect has been in the city itself in promoting mendicancy. Only last Christmas one of the Boston papers was calling attention, with evident satisfaction, to the vast increase within a few years in the number of Christmas turkeys distributed gratis to the poor; as if such an evidence of the progressive pauperization of the community was not more to be deplored than the increasing liberality of a few to be rejoiced over. On the other hand, Mr. Smiley, in the address to which we have referred, states that the discontinuance of out-door relief in Brooklyn, Cleveland, and Cincinnati has been followed by an almost complete disappearance of any visible necessity for the administration of such relief.

The morality of the future, we may therefore safely say, will be based less upon self-sacrifice than upon individual culture and self-restraint, and will exhibit more and more the beneficent workings of what Mr. Spencer calls the law of equal liberty. This, indeed, is the only moral *régime* befitting the industrial and democratic stage of society. In ages of great social inequality, when the great tyrannize and the weak cringe in submission, there is urgent need for the intervention of generous spirits to do and to dare what the victims of oppression can neither do nor dare for themselves; but with the removal of all unjust privileges the need for such action largely disappears. If unduly prolonged its effect is to make the weak weaker, the helpless more helpless. The time, we hold, has come now when, broadly speaking, the best thing any man can do is to hold himself erect, to practice a high-minded justice in his relations with his fellow-men, and to eschew all modes of action calculated to encourage others to expect that they may reap where they have not sown. Speaking broadly again, our present modes of charity tend to no good. A truer charity by far would be to vigorously protect society from the vicious and criminal class; and, in regard to the limited class of non-vicious paupers, to let them understand that what they earn they shall eat and no more. This is the course we shall follow if we want a perfected society. If, on the other hand, we are prepared to make all sacrifices, alike of principle and of expediency, for the sake of emotional gratification, we shall proceed in the practice of an ever-extending sentimental charity; and the poor and degraded we shall ever have with us, and yet more abundantly.

"*THE VALUE OF THE NEXT-TO-NOTHING.*"

Sir Frederick Bramwell, President of the British Association, chose as the subject of his inaugural address the singular reading, "The Value of the Next-to-Nothing; and the Civil Engineer, and the Value to Science of his Works." His purpose was to show how the civil engineer, applying results already worked out by science, enlarging resources and facilities and increasing economy, had aided and stimulated science to new researches to be utilized again in his own inventions, which were in turn to give a further impulse to scientific work. A very large proportion of the engineer's success was due to his regarding infinitesimals; and in respect to this point it was appropriate for the speaker to show how greatly infinitesimals or "next-to-nothings" determine the strength, the fitness, and the durability of works and materials. Take the case of steel, which in times that are not very old was dealt with and tested in a "rule-of-thumb" fashion. It was known to be a compound of iron and carbon—

"but the importance of exactness in the percentage was but little understood, nor was it at all understood how the presence of comparatively small quantities of foreign matter might necessitate the variation of the proportions of carbon. The consequence was, that anomalous results every now and then arose to confound the person who had used the steel, and, falsifying the proverb 'true as steel,' steel became an object of distrust. Is it too much to say that Bessemer's great invention of steel made by the 'converter,' and that Siemens's invention of the open-hearth process, reacted on pure science, and set scientific men to investigate the laws which regulate the union of metals and of metalloids, and that the labors of these scientific men have improved the manufacture, so that steel is now thoroughly and entirely trusted? By its aid engineering works are accomplished which, without that aid, would have been simply impossible. The Forth Bridge, the big gun, the compound armor of the ironclad with its steel face—all equally depend upon the 'truth' of steel as much as does the barely visible hair-spring of the chronometer, which enables the longitude of the ship in which it is carried to be ascertained. Now, what makes the difference between trustworthy and untrustworthy steel for each particular purpose? Something which, until our better sense comes to our aid, we are inclined to look upon as ridiculously insignificant—a 'next-to-nothing.' Setting extraneous ingredients aside, and considering only the union of iron and carbon, the question whether there shall be added or deducted one tenth of one per cent of carbon is a matter of great importance in the resulting quality of the steel. This is a striking practical instance of how apparently insignificant things may be of the highest importance. The variation of this fraction of a percentage may render your boiler-steel untrustworthy, may make the difference between safety in a gun and danger in a gun, and may render your armor-piercing projectile unable to pierce even the thinnest wrought-iron armor."

So the effects upon steel of adding manganese—whether it shall improve or deteriorate the metal—are matters of rather delicate calculation—

"and the effects of the addition of even the very smallest percentages of aluminum upon the steel with which it may be alloyed are very striking and very peculiar, giving to the steel alloy thus produced a very much greater hardness, and enabling it to take a much brighter and more silver-like polish. Further, the one twentieth part of one per cent of aluminum, when added to molten wrought-iron, will reduce the fusing-point of the whole mass some five hundred degrees, and will render it extremely fluid."

The engineer engaged in electrical matters is also often compelled to realize the importance of the "next-to-nothing," as in the case of the influence which an extremely minute percentage of impurity has on the electrical conductivity of copper wire. This conductivity is, in some cases, reduced as much as fifty per cent, in consequence of the admixture of that which, under other circumstances, would be looked upon as insignificant.

The internal strain which a great gun may suffer in the process of oil-hardening, by the operation of which it may be self-ruptured months afterward, is gauged in the most minute fractions of an inch. The various degrees to which a tool is tempered according to the uses to which it is to be adapted, all depend upon the "next-to-nothing" differences in the temperature to which the metal is heated. Then—

"consider the bicycles and tricycles of the present day — machines which afford the means of healthful exercise to thousands, and which will probably, in a very short time, prove of the very greatest possible use for military purposes. The perfection to which these machines have been brought is almost entirely due to strict attention to detail; in the selection of the material of which the machines are made; in the application of pure science (in its strictest sense) to the form and to the proportioning of the parts, and also in the arrangement of these various parts in relation the one to the other. The result is, that the greatest possible strength is afforded with only the least possible weight, and that friction in working has been reduced to a *minimum*."

Finally, the hardly appreciable difference in the density of the air on the upper side and the under side, of a shot issuing from a gun is sufficient to deflect the missile toward either side, according to the "hand" of the rifling, to such an extent that it has to be allowed for in the sighting and rifling of guns designed to be fired at long range. So, in fixing long-range guns, pointing north and south, the difference in the velocity of the earth's rotation at the two ends of the range has to be taken into consideration.

Sir Frederick's address having begun by showing how applications of science and discoveries act and react upon and further one another, and having illustrated the importance of minute details in this mutual helping, closed with a demonstration that engineering has a poetical side.

The building of such a work as the Eddystone Lighthouse, the throwing of a long and lofty span across a navigable river or strait, or the tunneling under a body of water—like the English Channel, for instance—with the closer bringing together of peoples that would result from it, or the execution of a sanitary work that will reduce disease one half—a thing that is not unknown—afford abundant scope for emotion and flight of the imagination. Whether it be these, or the supply of pure water to every dwelling—

"or the distribution of light or of motive power; or whether it be in the production of the mighty ocean-steamer, or in the spanning of valleys, the piercing of mountains and affording the firm, secure road for the express-train; or whether it be the encircling the world with telegraphs—the work of the civil engineer is not of the earth earthy, is not mechanical to the exclusion of science, is not unintellectual; but is of a most beneficent nature, is consistent with true poetical feeling, and is worthy of the highest order of intellect."

LITERARY NOTICES.

Animal Memoirs. Part I.—Mammals. By Samuel Lockwood. New York and Chicago: Ivison, Blakeman & Co. Pp. 317.

This book is the first of a projected series of "Readings in Natural History," in which the author purposes to present mainly individual portraits, or animal biographies, in the fourfold setting of their morphology, physiology, chorology (or geographical occupancy), and origin, "but so far as possible without technicality of treatment, and with as little formal limning as is compatible with clear and truthful outlines." Preference is given, where possible, to such creatures as the author has known with the intimacy that attaches to pets. In accounting for the origin of the book, Prof. Lockwood describes how his own interest in natural history began. It arose from his picking up, while he was a very small boy, a torpid snake which had been chilled in a severe storm. Having taken it home, he was examining its diamond-pointed scales, when it revived under the influence of the warmth, and was at once dispatched by an older brother. "I felt very badly," he says, "to have it taken from me. But a little picture of its ornamentation held a place for a long time in my memory. The pattern was a mosaic of pretty geometric figures. From that time on my taste grew. I had that day got a nibble in the lane which led to the rich and open field of nature. What an appetizer it proved to be! I hungered for more. My first book was Goldsmith's 'Animated Nature,' which was read and reread with avidity. I took in everything, even the wild statement that Indians had passed safely over the Falls of Niagara in their canoes." The key to the author's mood is given in the sentence, "With the imagination and judgment in healthful union, let one enter into the mind of the animal—that is, put himself in its place—and it will be surprising how much of one's self can be seen in that lowly thing." Prudence and foresight, forecasting of the weather, magnanimity, and sympathy in distress, or something that works very much like them, may be seen in different degrees of development in certain animals. A story of a doctor at Long Branch, who had a hen that took a kitten as one of her chickens, is offset by one of a cat in the old country, which, being given a chick partly emerged from the shell, "began at once removing the shell in the most tender way; and this done, she put the callow thing by the side of her kitten and nestled them together"; and was grieved when the attempt was made to take the chick from her. Intelligence and a kind of scientific scrutiny were shown by the turkey that swallowed grasshoppers, which it knew all about, "without stopping to think," but when given a large black beetle, "very deliberately put down his head and inspected the insect; then stepped back quite cautiously, then approached, and, stooping as before, again gazed at it intently. Not yet satisfied, he now walked around it with a curiously cautious strut, keeping his eyes all this time upon the dubious morsel. Now his movement is quicker, and, becoming assured, he seizes the insect and it is swallowed at once." The opening chapters exhibit in various ways what is styled "the exuberance or overflow of 'animal mind,'" in the hope of awakening in the reader the faculty of insight, "so that he may be to the animal what it so often is to him—'a discerner of spirit.' For, is it not too apparent that in this respect the 'dumb beasts which perish' are often our superiors? In divining the mind of his master the dog rarely errs; and how subtle his discrimination of 'the stranger at the gate'! These mental manifestations indicate the one maker of animals and men. . . . No pessimist ever made much in the study of the life-histories of animals. The student of such had better be optimist out and out." With these animals "are all kinds of mental manifestation—the gleesome and the serious, the pathetic and the sympathetic, the jocose and the morose." The first story illustrating "animal humor" is of a monkey in a basket-shop, which was the pet of the men and boys, and afforded them all manner of sport until they became tired of it and began to play malicious tricks upon it, when "it broke down, as if it had concluded to drop all sport forever. Not at all vicious, still gentle, but joyless, it became chronically sad"—but recognized a sympathetic voice when "the minister" called upon it, and reposed in him all the confidence and affection it had lost toward other men. Another monkey, which was kept in a cage, was suspicious and even vicious toward strangers, but became friends at sight with this same "minister," greatly to the surprise of its owner—"taking his measure at a glance." Another trait was exhibited by Frank Buckland's monkeys, which would care nothing for a carrot when given to them, but would eagerly avail themselves of an opportunity to steal it. We are not willing to say that this is a human trait, though some men seem ready to illustrate it. The stories of dogs afford displays of intelligence which must appear wonderful and almost incredible to all except those who are well acquainted with dogs, to whom they will have an air that is less novel. They show most remarkable perceptions of what is going on, of what the family and persons around wish, of what is intended to be done, and apparent understanding of language. These stories—of "animal humor"—are largely of animals within the author's own acquaintance. Those that follow—of sledge-dog antics (arctic), the onithorhynchus and its eggs, the kangaroos, coons, the coati mundi (concerning which Prof. Lockwood has contributed an article to the "Monthly"), the kinkajou, rabbits, and mice—are drawn largely from the observations of other writers. In the cases of the stranger animals the differences in their structure from that of the ordinarily mammalian type are duly explained, the technical terms being translated into intelligible English; and the final chapter is on "Classifying Animals."

Numbers Symbolized: An Elementary Algebra. By David M. Sensenig. New York, Boston, and Chicago. D. Appleton & Co. Pp. 315. Price, $1.26.

This volume is introductory to a more extensive and philosophical treatise with which the author designs to follow it. In scope it includes all subjects essential to a study of higher arithmetic, elementary geometry, and the elements of physics. All topics are treated in an elementary manner, with broad generalizations and discussions of general problems purposely excluded. In the earlier lessons, fundamental ideas and principles are developed inductively, and then formulated into simple and concise statements; each definition, for example, is preceded by a problem that asks for it, making it thus something suggested by what has gone before, rather than an arbitrary statement, the meaning of which is to be found out by subsequent application. Further on, definitions appear at the beginning of subjects, and principles are deduced from the solutions of characteristic examples. And, still later, propositions are first enunciated and then logically proved. Thus the pupil is led by easy transition from the more elementary forms of reasoning to pure mathematical demonstration. Examples have been carefully selected both to be worked at sight and for written work, while long and pointless examples have been generally avoided. Factoring is treated with considerable fullness.

Essays on God and Man; or, a Philosophical Inquiry into the Principles of Religion. By the Rev. Henry Truro Bray, Boonville, Mo. St. Louis: Nixon-Jones Printing Company. Pp. 270. Price, $2.

The author, who is an Episcopal clergyman, assumes that "men are everywhere drifting away from the old beliefs"; that the intellect of the world has "lost all faith in the Church of the past"; and declares that in his own experience he hardly ever finds a man who believes unqualifiedly the doctrines of the pulpit. Yet he has faith in the reality and permanence of religion, whose essence has been overlaid by glosses and superstition. In this book he hopes "in a measure to lead his readers to discriminate between the evanescent and permanent, between the temporal and the eternal; and to know that while they may doubt and reject the evanescent, the local, or the temporal, they should not and may not reject the permanent, the universal, or the eternal." He lays down as embodying the faith of the scientific world the propositions that "there is an infinite intelligence whom we call God; man is by nature a religious being; every religion has in it a nucleus of truth; no religion is exclusively true, or founded upon an exclusively divine revelation." And he attempts to show that religion is useful and natural; that its essentials are one; that God's revelation is universal and continuous; that God has been no more mindful of one race than of another, and is immanent in the universe, especially in intelligences; and "that our Bible, as the other Bibles of the world, is, in the higher sense, but the history of the attempts of the people to express the impressions made on the mind by God immanent in nature." He further seeks to discriminate between what is divine and what is human in religion, and to show that man may reasonably expect a future life.

The Constants of Nature. Part I—A Table of Specific Gravity for Solids and Liquids. By Frank Wigglesworth Clarke. Washington: Smithsonian Institution. Pp. 409.

The author published, in 1872, through the Smithsonian Institution, a "Table of Specific Gravities, Boiling-Points, and Melting-Points for Solids and Liquids," which Prof. Henry made the first part of a work he was contemplating under the title of "The Constants of Nature." Other parts were contributed by Prof. Clarke, and one part by Prof. G. F. Becker. The present volume is in effect a new edition of Part I, revised, rearranged, and brought down as nearly as possible to the date of printing. The tables are, however, modified by the omission of boiling and melting points, except when those data seem essential to the proper identification of a compound, that want being supplied by Prof. Carnelley's tables. The tables contain the specific gravities of 5,227 distinct substances, and 14,465 separate determinations.

Entomology for Beginners. By A. S. Packard. New York: Henry Holt & Co. Pp. 367. Price, $1.40.

This work, the author of which is an eminent naturalist, is intended for the use of young folks, fruit-growers, farmers, and gardeners. While amateurs and dilettant entomologists may find useful hints in it, "the needs of those who wish to make a serious study of these animals have not been overlooked, and it is hoped that the book will be of some service in leading such students to pay more attention to the modes of life, transformations, and structure of insects than has yet been done in this country." Prominence is given to accounts of injurious insects, in regard to which, besides the matter here furnished, references are made to descriptive works and reports for fuller information. Some changes are made in classification. Believing that some of the lower orders, such as the "Orthoptera" and "Pseudo-neuroptera" are heterogeneous, unnatural groups, which ought to be broken up into distinct orders, sixteen orders instead of eight are formed. Considering that there are probably about a million species, this number is thought not to be too many. The general principles and descriptions are followed by particular accounts of insects injurious to agriculture, with prescriptions of remedies against them, and information on collecting and rearing insects, dissecting, preserving, and microscopic mounting, and a bibliography—"The Entomologist's Library."

Old and New Astronomy. By Richard A. Proctor. London and New York: Longmans, Green & Co. In twelve monthly parts. Pp. 64, with two Plates each. Price, 2*s.* 6*d.* each.

The first five parts of this work have been received. It was the design of the author to make it the great work of his life—the one, as he himself has said, for which all the treatises on astronomy that he had hitherto produced, and also his astronomical essays and lectures, were preparatory. The chief object of it is to present in popular yet scientifically sound form "those views of the heavenly bodies which are included in what, in his last poem, Tennyson calls the 'New Astronomy'"; the life-histories of worlds and suns, studies of the planets as illustrating the stages of our own earth's life, and of the record of the earth as illustrating the life-histories of the planets; of the sun as the one star we can examine, and thus as telling us all we know in detail about the nature of other suns, and of the stars as illustrating the life of the solar system. There are also presented points of detail in which the astronomy of to-day differs from the astronomy of a quarter of a century ago—relating, among other things, to the structure of the galaxy, the sun's condition and surroundings, the condition of the various orders of bodies attending on the sun, the recognition of the moon as presenting the history of our earth's past as well as future life, and comets and meteors. Fuller explanations than the old ones are given of the tides and the precession of the equinoxes. The illustrations are of prime excellence, and a large number of them original. We are not aware whether the author had completed his work; but, even if he has left it unfinished, that which is already published may be regarded as a valuable addition to astronomical literature, and as giving the "latest news" on the subject.

Vierteljahresschrift über die Fortschritte auf dem Gebiete der Chemie der Nahrungs- und Genussmittel (Quarterly Review of Progress in the Chemistry of Foods and Condiments). Edited by Drs. A. Hilger, J. König, R. Kayser, and E. Sell. Vol. II. 1887. Berlin: Julius Springer. New York: B. Westermann & Co. Pp. 692. Price, 14 marks.

The contents of this periodical, of which we have here the four numbers of the year stitched into one, hardly need any other description than the title. It is compactly filled with reports, analyses, receipts, statistics, and other matter related to the subject, given under such headings as "Meat," "Peptone and Meat Preparations," "Milk," "Oils," "Sugars," "Spices," "Fermentation-Phenomena," "Water and Water-Provision," "Preserves and Preserving Media," "Useful Articles," "Methods of Analysis," "Microscopic Investigations," "Laws," "Literature," and others of similar character. Only facts receive attention.

A Sketch of the Germanic Constitution, from Early Times to the Dissolution of the Empire. By Samuel Epes Turner, Ph. D. New York: G. P. Putnam's Sons. Pp. 185. Price, $1.25.

Though concerning only the political changes achieved by a particular people among the European powers, the history of the Germanic Constitution at all epochs of its development is of general interest—in early times, because of the contributions which the Germanic stock made to the blood, language, laws, and customs of the various states; in later times, because of the controversies and wars that turned around German pretensions, and of the lead taken by Germany in the Reformation; and in the present, because of the prominence that is accorded to German thought and German policies. The "sketch" begins with the accounts of the Germans given when they first began to attract attention by the Roman authors, and is continued by periods—the "Merovingian," "Carlovingian," "First Feudal," "Second Feudal," and "Reformation" periods, the "Period of Disintegration" and the "Period of Dissolution," ending in 1806. The Constitution of the new empire is not considered.

The third number of the proceedings of the *American Society for Psychical Research* (Damrell and Upham, 50 cents) opens with a paper, by Miss Alice C. Fletcher, on the "Supernatural among the Omaha Tribe of Indians," embracing myths regarding the origin of woman and the entrance of death into the world, beliefs about the fortunes of the spirit after death, and about ghosts, together with a variety of superstitions and legends. This is followed by a "Criticism on 'Phantasms of the Living,'" by Prof. C. S. Peirce, with "Remarks on Prof. Peirce's Paper," by Edmund Gurney, and "Mr. Peirce's Rejoinder." In his criticism, Prof. Peirce states sixteen conditions to which he says the thirty-one coincidences between a visual hallucination and a death, mentioned by Messrs. Gurney, Myers, and Pedmore, ought to conform, but one or more of which are sinned against by every one of the thirty-one cases, and concludes that "the evidence, so far as it goes, seems to be rather unfavorable to the telepathic character of the phenomena." Mr. Gurney admits the weakness of a few cases, defends others, and gives additional evidence in support of some, but yields no important point. Prof. Peirce's rejoinder deals with the mathematical probabilities of the thirty-one cases being accidental coincidences, and reviews some of the cases in detail. This discussion is followed by brief reports from several committees. The experiments and investigations of the Committee on Thought-Transference had yielded little but negative results. The Committee on Experimental Psychology had received five hundred returns from a blank designed to test the prevalence of superstition regarding sitting down thirteen at table, beginning a voyage on Friday, seeing the new moon over the left shoulder, and occupying a house reputed to be haunted. Of three hundred and nine men, about one tenth were more or less influenced by the first three superstitions, and of one hundred and ninety-one women about two tenths. The form of the fourth question is not such as to separate the respondents who have a belief in the superstition from those who have not. The Committee on Apparitions and Haunted Houses deemed the last part of their designation a misnomer, as they had not been able to learn of any house which was reputed to be haunted at the present time. They reported a number of well-authenticated cases of presentiments, and stated that materials for their research were coming in quite freely. The Committee on Mediumistic Phenomena reported that professional materializing mediums could not be got to give *séances* under conditions suitable to a scientific investigation, and that where non-professional mediums had given such *séances* the results were negative. A paper by the chairman, on "The Basis of Investigation of Mediumistic Phenomena," was appended to the report. This is followed by two papers on hypnotism, and one on "The Consciousness of Lost Limbs."

"The American Folk-Lore Society" has been formed for "the study of folk-lore in general, and in particular the collection and publication of the folk-lore of North America." Its President is Prof. Child, of Harvard; William Wells Newell, of Cambridge, Mass., is the Secretary; and among its other officers are many well-known American anthropologists. Its medium of publication is *The Journal of American Folk-Lore* (Houghton, $3 a year), a quarterly magazine, the second number of which is before us. W. W. Newell is the general editor. This number contains ten articles, treating of Indian myths and customs, folk-lore of the Pennsylvania Germans, superstitions and tales of the negroes, etc., together with departments for notes, items, meanings of words, and titles of articles on folk-lore in American and foreign journals. The field to which the journal is devoted is exceedingly interesting and instructive, and is one in which the material for study should be seized upon at once, for it will soon be too late.

Part II, of Vol. IX, second series, of the *Journal of the Academy of Natural Sciences* *of Philadelphia*, comprises a paper by W. B. Scott, entitled "On some New and Little-Known Creodonts," describing *Mesonyx obtusidens*, *Hyænodon horridus*, and several other species, with three plates, and a paper by Henry Fairfield Osborn, entitled "On the Structure and Classification of the Mesozoic Mammalia," with two plates, and a number of figures in the text.

The Elisha Mitchell Scientific Society (Chapel Hill, N. C.) gives evidence by its *Journal* that its fifth year has been one of activity and progress, and has contributed to the advancement of science in the South. Fifty-five papers have been presented to the society during the past year, dealing with subjects in chemistry, mathematics, ichthyology, entomology, meteorology, etc., a large part of which are published in the "Journal." Eight regular meetings were held during the year, and three public lectures delivered.

The first number of *Insect Life*, a periodical bulletin of the Division of Entomology, United States Department of Agriculture, appeared in July. It will be issued under the direction of Prof. C. V. Riley, United States Entomologist, and is designed to contain short papers, notes, and correspondence, which it is desirable to give to the public without delay, or which would be too disconnected for use in the annual reports or in the special bulletins of the division. The present number contains a variety of information, consisting of descriptions of several noxious insects, notes on the habits of others, and records of experience in using certain insect-exterminators, all of which promises well for the usefulness of the periodical.

In *Facts about Ireland*, Mr. *Alexander B. MacDowall* presents the condition of Ireland, and the changes it has undergone, in graphic diagrams or by curves (Edward Stanford, London). Under this system, plates are presented showing the relative changes in population in Ireland, England and Wales, Scotland, and London, by decades since 1801; and the statistics, in Ireland of agriculture, education, emigration, evictions, drunkenness, crime, consumption of spirits, bank deposits, revenue, value of crops, and occupations. Each plate is accompanied by a page of letterpress, calling attention to its significant points. The author hopes that these diagrams may prove of some little use in the study of the Irish question. They certainly show at a glance much that it would take considerable reading to learn otherwise.

The *Colloquia Latina* of Mr. *Benjamin D'Ooge*, of the Michigan State Normal School (D. C. Heath & Co.), is a collection of dialogues intended to form the basis for exercises in conversational Latin. It is the outgrowth of methods pursued by the author in his own classes, and most of the dialogues have been tested by actual use. Its purpose is to give greater interest and life to the study, and more thoroughness. The dialogues give the models or forms of expression, after which conversations may be carried on about the subjects, in Latin; while the notes elucidate the grammatical and idiomatic peculiarities which come under notice.

In *Selected Poems from Premières et Nouvelles Méditations* (D. C. Heath & Co.) Prof. *George O. Currie* has prepared a collection of Lamartine's poems, with notes, for schools and classes. The author represented is a poet of the highest merit—"the Christian Virgil, only greater, and just as pure and refined," in the editor's view—and the choice gives a fair test of his quality. Notes are appended, which are both grammatical and literary in character; a sketch of Lamartine's life is given; and an article by Prof. A. Williams, of Brown University, on the "General Character of French Verse," adds to the value of the work as a whole.

An Iceland Fisherman, by *Pierre Loti* (New York, Gottsberger), is a story by a French author of rising fame. His real name is Julien Viaud, and he served during the Franco-Chinese War on a French naval vessel. The adventures which befell him during his cruisings in the Oriental seas furnished him with materials for many vivid stories and sketches, which proved very acceptable to the public. The present story, though written among more quiet scenes at his home near Rochefort, is marked by similar qualities. The translation is acceptably done by Clara Cadiot.

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POPULAR MISCELLANY.

Death of Richard A. Proctor.—Mr. Richard Anthony Proctor, the distinguished writer and lecturer on astronomy and other subjects, died in this city, September 12th, of yellow fever. He had left his home at Oak Lawn, Florida, to go to England and fulfill some lecture engagements, and had engaged passage on one of the steamers appointed to sail on the following Saturday. He was apparently in good health, and there had been no yellow fever at Oak Lawn; but very soon after reaching his hotel he complained of being ill. A doctor was sent for. His disease rapidly developed. He was transferred to the Willard Parker Hospital, and died there, in less than sixty hours after he was first taken. A portrait of Mr. Proctor and a sketch of his life up to that time were given in the "Monthly" for February, 1874. His life has been a very busy one since then. He has written incessantly, contributing to journals of every kind, on a great variety of subjects, but always with the most interest on those relating to astronomy. A few years ago he started a periodical, first weekly, afterward monthly, called "Knowledge," which was devoted principally to the popularization of science, and to which he was himself a voluminous contributor, writing on all sorts of subjects, from "Americanisms" and "Whist" to the purposes for which the Pyramids were built. He also wrote under a variety of signatures; in his own name, in astronomy; as "Edward Clodd," on dreams and evolution; as "Thomas Foster," on morals and other abstruse subjects; as "Mephisto," on chess; and as the editor of several departments. In his earlier life he accomplished something in original research, at which he would have gladly continued, but financial embarrassments compelled him to do that which would bring money at once—and hence the prolific fruits of his pen. In 1884 Mr. Proctor married, as his second wife, Mrs. Robert C. Mallery, of St. Joseph, Mo., where he lived till he removed to Florida in 1886. He had erected at Oak Lawn an observatory, where he was accustomed to spend much of his time, reviving the original work of his earlier days, and had been engaged in later years upon a book which he had intended to make the crowning work of his life and his most solid title to fame, "The Old and New Astronomy." It was to be published in twelve monthly parts, by Longmans, Green, and Longmans, London and New York. We are not informed whether the manuscript of this work has been completed; but we understand that the sixth part is now ready for delivery. One of the last articles he wrote was that in "Harper's Weekly" for September 22d, on the "Moon a Dead World (but not like our Earth)," in which he held that the differences in the character of the lunar and terrestrial surfaces are owing to differences in the extent to which denudation has worked on the respective bodies. He also left several manuscripts in the hands of one of the newspaper "syndicates."

The Teaching of Physics in Schools.—The Committee of the American Association on the Teaching of Physics expresses the opinion in its report that the teaching may begin with profit in the "grammar-school," but decidedly opposes any general recommendation that it must begin there or in the primary school. "Here, perhaps more than anywhere else, nearly everything depends upon the teacher." When taught in the grammar-school and by a competent teacher, it should be done mainly by and through illustrative experiments, which may be of the simplest character, involving and exhibiting some of the fundamental principles of the science; and these should generally be made by the teacher, the pupils being encouraged to repeat, vary, and extend. The course of study in the high-schools should be in harmony with the fact that the large majority of the young people who are educated in the public schools receive their final scholastic training there. It is important that the student should be made acquainted, if only to a limited extent, with the methods of physical investigation, and that he should be able himself to plan and carry out an attack upon some of the simpler problems of the science. In a high-school course of four years of three terms each, the study should not begin before the third year, and should be continued, with three hours a week of class-teaching, for one year—text-book work with illustrative experiments by the instructor during the first two terms, and simple laboratory exercises in the third term. A course like this should be required as preliminary to admission to all courses in college.

Ancient Egyptian Medicine.—The ancient Egyptians had abundant opportunities in performing the preparatory processes for embalming to become acquainted with the structure and some of the functions of man's physical system. Hence medicine flourished among them from an early date. Medical colleges existed in the priestly schools of Memphis, Heliopolis, Sais, and Thebes. Two nearly complete medical treatises of very great antiquity are still extant, and fragments of others. The Ebers papyrus, which is written in hieratic characters resembling those of the earlier writings of the eighteenth dynasty (B. C. about 1550), begins, after the conventional prefatory adjuration, with a section on hygienic measures and simple remedies. This is followed by a section on the parasite *Bilharzia hœmatobia*, which is still common in the Nile Valley. Other diseases are then treated of, including those of the eye, which have always been among the most serious afflictions of Egyptian life.

Twenty-four prescriptions for hair-washes, oils, depilatories, and dyes are given. Among them is one "to stimulate the growth of hair, prepared for Sesh, the mother of his Majesty King of Upper and Lower Egypt, Teta the blessed," which carries us back to the beginning of historic time, for Teta was the second king of the first dynasty, and his mother, Sesh, may have been the queen of Menes, the founder of the empire. Under the heading of "The Beginning of the Mystery of Medicine, Knowledge of the Motions of the Heart, and Knowledge of the Heart," are described the vessels "from it [the heart] to all parts"; "and it is the beginning of the vessels to each organ." Concerning the animal spirits, we are told that these vital spirits "enter one nostril, and penetrate to the heart through the tube which carries them into the body-cavity"; and "there are four vessels going to the two ears together, two on the right side, two on the left side, carrying the vital spirit into the one right ear, the breath of death into the left ear; that is, it enters on the right side, the breath of death enters on the left side."

Preglacial Cave-Men in Wales.—Dr. H. Hicks read in the British Association accounts of some explorations which he had carried on in certain Welsh caves as affording evidence of occupation by pleistocene men and animals before the glacial beds which occur in the area had been deposited. It was found that, although the caverns are now four hundred feet above the level of the sea, the materials within them had been disturbed by marine action since the pleistocene animals and man had occupied them. At Stet Cave a small, well-worked flint flake had been discovered beneath twenty feet of glacial beds. It seemed clear that the contents of the cavern must have been washed out by marine action during the great submergence in mid-glacial times, and then covered by marine sand and an upper bowlder-clay. The author believed that the flint implements, lance-heads, and scrapers found in the caverns were also of the same age as the flint flake; hence they must all have been the work of preglacial man. Prof. Boyd Dawkins accepted the evidence of the antiquity of man, and fully agreed with Dr. Hicks's conclusions. To Mr. W. Pengelly this was a "delicious discovery," inasmuch as he had long stood to a great extent alone in the opinion that the nodule flint tools in Kent's cavern were of preglacial make. The explorations are to be continued.

Subjects for Industrial Training.—Mrs. Laura Osborne Talbot thus described to the American Association her experiences of the effects of a little industrial teaching upon thirty vagrant boys whom she, with some other ladies, had induced to attend for three years an industrial class at Howard University one morning in the week: "We were limited in every way, but we found these children of the lowest kind were delighted to work with tools, and some of them have set up little carpenter-shops of their own, and support themselves in that way. The moral uplifting was the best result of all, and it is not likely that these boys will become members of our criminal class. Each boy as he entered the class was taught in the tailor-shop to mend his clothes, and in the shoe-shop to mend his shoes. One lame colored boy from the orphan asylum became so skillful in shoemaking that he could not only make his own shoes, but could cut up the larger, half-worn shoes and make them over for baby feet. All of this I term the best kind of economy, especially in a city like Washington.

Contents of a North Carolina Mound.—Mr. J. M. Spainhour has described, in the Elisha Mitchel Scientific Society, some relics that were discovered in the excavation of a mound in Caldwell County, N. C. Within the mound was found a skeleton lying upon its face, with the head resting in a large sea-shell, the inner surface of which was carved with hieroglyphics. Around the neck were large beads made of sea-shells. The arms were extended and bent at the elbows, so as to bring the hands within about a foot of the head. Around each wrist was a bracelet, composed of copper and shell beads, alternating. The copper beads appeared to have been hammered into thin sheets and rolled around the string, a part of which was preserved. Near the right hand was an iron implement like a chisel or punch, not sharp-pointed, but smaller at the end away from the handle. The left hand was resting on the convex surface of a sea-shell, the concave surface of which contained about a hundred small beads. The shell was carved with hieroglyphics. Two other skeletons, on either side of this one, also had their heads resting in the concave surfaces of shells, which were marked with hieroglyphics. Several other skeletons were found around and above the principal one, which was thought to be the remains of a chief. In another part of the cemetery were found skeletons of persons who had evidently been buried alive, their limbs having been held down by large stones placed upon them.

Sanitary Plumbing.—Dr. Sinclair White, recently medical officer of health at Sheffield, England, in a late sanitary report, recommends, for use among the poorer and less intelligent inhabitants of towns, the form of multiple water-closet known as the trough-closet or water latrine. The trough is composed of strong glazed earthenware, in sections, with a seat to each section. The seats are separated by partitions. The trough may comprise any number of sections. A pipe from a flush-tank enters one end, and it has a connection with the sewer at the other, a trap and inspection hole intervening. Water stands in the trough to the depth of three or four inches, and it may be flushed automatically or by hand.

Important Archæological Monuments.—The American Association's Committee on the Preservation of Archæologic Remains recommended that measures be taken for the preservation of the following works: Chaco Cañon, from the forks of Escavada Cañon for a distance of eight miles up; Cañon de Chelly, Cañon del Muerto, and Walnut Cañon; the ruin of Fossil Creek, on the east branch of the Rio Verde, and about fifteen miles south of Camp Verde military reservation; ruins in Mancas Cañon, the Round Towers situated on the flat valleys of the Lower Mancas, and the Cavate Lodges in the cinder-cone, about eight miles east of Flagstaff, Arizona Territory. The report continues: "Besides these groups of ruins and dwellings, there are isolated remains in the Territories of New Mexico, Arizona, and Utah, numbering over forty, which demand preservation. The Pueblos, which are not on treaty reservations or grants, and the old Mandan and Arickaree village on the Port Berthold Indian reservation in Dakota, to be preserved when they cease to be inhabited by the Indians. Also certain burial and village sites in Alaska." The committee—Alice C. Fletcher and T. E. Stevenson—have caused a bill to be introduced in Congress providing for a reservation in New Mexico for the purpose of archæological study.

Uses of Photography in Science.—In describing some of the applications of photography to scientific purposes, Mr. H. Trueman Wood mentions, as among the advantages of the art for such uses, that it is an absolutely unprejudiced observer. The sensitive plate records, with absolute fidelity, the image thrown upon it. The sensitive surface further has the power of storing up feeble impressions of light, so that an image is produced by the long-continued impact of vibrations too feeble to have any effect until they have been allowed to impinge upon the plate for a considerable time; while, on the other hand, the light-rays, if of sufficient energy, can produce their due effect in a time which, to human appreciation, seems infinitely small. Again, the photographic plate is affected by rays to which the eye is quite insensitive, and thus by its aid we can take cognizance of, and observe, rays beyond the limits of the visible spectrum, of the highest and of the lowest refrangibility. Thus, the photographic lens will record the impression of an infinite amount of detail, to reproduce which by any other method would require immense time and labor. The most important services which have been rendered by photography to science are in astronomy; in photographs of the moon, of the sun, and of eclipses, in which possibly evanescent phenomena are put on permanent record for the study of after-years. The work of cataloguing and charting the stars, and accurately locating them, has been greatly aided; has been, in fact, set in a new aspect by means of photography. Then we have the photographs of the nebulæ, one of which, Mr. Common's view of the nebula in Orion, Mr. Lockyer has declared to be one of the greatest achievements in astronomy, of a value greater than that of all the eye-observations made during the past two and a half centuries. In astronomical spectroscopy, by which great discoveries have been made respecting the constitution of the heavenly bodies, photography has had it all its own way. Meteorologists have made use of photography in various ways, as in application to self-recording instruments of various kinds, and in observations of cloud-forms and distances, and of lightning. In chemistry and physics, the best photographic work has been done by the camera when allied with the spectroscope. In the biological sciences and in medicine the applications of photography have been many and various. Anthropology finds a valuable aid in photography, which reproduces and perpetuates the types and peculiarities of races and of individuals. In the study of natural history, probably the most important work done by photography lies in the direction of photo-micrography; and in such researches as those of Mr. Muybridge and M. Marey on animal locomotion. The value of photography in geographical science is now so well admitted that an explorer would almost as soon think of starting without a rifle as without a camera.

Time-Reckoning of Puget-Sound Indians.—According to Mr. M. Eells's account of "The Indians of Puget Sound," in the "American Antiquarian," the Nisquallies divide the year into thirteen moons, for each of which they have separate names; also for the waxing and waning of the moon. The daytime is divided into dawn, sunrise, forenoon, noon, afternoon, sunset, and dusk, while the night has the single division of midnight. These Indians obtained the idea of Sunday from another tribe, before the English came, and after that met on Sunday, sang, danced, prayed, and tried to purify themselves, and throw away their bad and make their hearts good. They also married wives on that day. Among the Twanas Sunday means holy day, and the other days are day past, two days past, etc., except Saturday, which means "alongside," that is, of Sunday. March is "getting warm"; August, "the deer sheds its horns"; October, "the grass dies"; and November, "the grass goes into the ground." The people are generally in debt to one another, with obligations of many years' standing. The debts are seldom heard of except when trouble arises about something else, and then there is a general turning up of old scores for ten or fifteen years back, and of the debts of relatives and wife's relatives. At one time, says Mr. Eells, an old Indian living at Seabeck was invited to a potlatch at Skokomish; he accepted the invitation, but while attending the feast his house was broken into and robbed of property of considerable value. As he could not find the trespasser, he claimed that the man who invited him to the potlatch ought to pay him; because, if the giver of the potlatch had not induced him to leave home, he would not have lost the articles."

An Evil of Civilization.—A curious account of the Yakutal Indians was given by Prof. William Libbey, Jr., in the American Association. The author mentioned the strength of the men as contrasted with the bent, labor-wasted bodies of the women, their aptness in mechanical arts, their strict idea of property, their superstitions, which are valuable as influencing fortune. A whole tribe got baptized to change their luck, and, when their luck did not change, the missionary had to. Their rapid decrease in numbers was due to changes in diet and clothing. In their climate the canned beef and cotton overalls of the white man proved poor substitutes for seal-fat on the inside and seal-skin without.

Lucigen.—By the "lucigen" apparatus, according to Mr. J. B. Hannay, a light is obtained from the burning of crude oil which exceeds in effective illuminating power any artificial light yet invented. The working of it depends upon the action on a powerful jet of mixed spray, hot air, and hydrocarbon vapor, driven by compressed air, of an aspirated sheet of hot air derived from the atmosphere. The flame takes the shape of a cylinder, tapering at both ends, about three feet long by nine inches in diameter, is intensely white, and is without smoke or smell. In this form it is available for open spaces and workshops, where a lateral diffusion of light is wanted. Modifications are imposed upon the apparatus to adapt it to almost every kind of building and work where it is desired to cast a large illumination over an irregular space. In one form, a light of from nine to eleven thousand candle-power, "actual," is obtained, which can only be compared with a conflagration. The size of the flame is so large that the shadows it casts are nebulous at the edges, and the volume of light so great that the shadows are partially illuminated by the reflections from surrounding objects, and the sharp contrasts and black shadows of the electric light are avoided. The same principle is adapted for heating purposes in the pyrigen, which gives a furnace free from sulphur, dust, and free oxygen, and of an absolutely steady temperature. The advantages are claimed for lucigen of low cost—it being one tenth that of gas-light of corresponding power—and extreme simplicity.

Fifty Years of Sanitary Work.—The progress of sanitation in England during the fifty years of the Queen's reign has been reviewed by Captain Douglas Galton. Affairs were in a bad condition at the beginning of the history, in the absence of systematic methods of counteracting the natural accumulation and operation of propagating conditions of disease. Parochial administrations operated mischievously, in degrading the habitations of the working-classes and checking tendencies to improvement. The window-tax had been in operation one hundred and fifty years, to foster darkness and bar out ventilation. Water-supplies and the disposal of sewage had hardly been thought of, except in the larger towns. The first complete registration of vital statistics was made in 1838. A report of the Poor-Law Commissioners on sanitary conditions embodied many recommendations and principles that have since been recognized in legislation. It is now computed that by means of the measures that have been made effective, the annual saving of lives, over the previously prevailing death-rate, was, during 1860–'70, 4,064; during 1870–'80, 13,929; and from 1880 to 1884, 21,847. The whole death-rate for England and Wales has been reduced from 22·07 to 19·62 per 1,000; of deaths by zymotic diseases, from 4·52 to 2·71 per 1,000. The improvement in the last point in urban districts does not, however, appear to have kept pace with that in rural districts. The present social condition of the people affords other evidence of general improvement. The main feature of the legislation of the past half-century is the recognition of the principle that when large numbers are congregated in communities the duty of preventing injury from this aggregation rests on the community.

The Relation of Roots to Moisture.—Variations in plants are often produced by differences in conditions of the environment which are imperceptible to the observer; so that different plants, proceeding from seeds of the same pod and growing close together, are hardly ever precisely alike. Mr. H. Marshall Ward has shown how variations may be occasioned by conditions affecting the root. The active roots are furnished with fine hairs, which go out and draw in the moisture. The drier the soil and the more difficult to get moisture from it, the more thickly set generally are the hairs. The soil consists of innumerable fine particles, of different shapes, sizes, and composition, and each of these particles is covered with a thin layer of water, a water-blanket, which adheres to it tenaciously; although, when the moisture-coating exceeds a certain thickness, they will yield the surplus up quite readily. There are spaces between these particles, each enveloped in its water-blanket, and these interspaces influence the quantity of water which can be held back by the soil. If we can suppose a soil to be perfectly dry, the interspaces will be filled with air; when the soil is made moist, some of this air is driven out as the water comes in to take its place. If the soil is made excessively wet, all or nearly all the air may be driven out, though this seldom happens. The functions of the root-hairs are chiefly to apply themselves in the closest manner to the surfaces of the particles of the soil, so that the water attached to them can pass from the soil to the plant, and, with it, whatever dissolved matter it may contain. Some of this matter is oxygen dissolved from the air-bubbles, and this oxygen is essential to the life of the root-hairs. The effect of the deprival of oxygen is then gradually to cause the death of the root-hairs, then of the rootlets, the larger roots, and so on, till the whole plant perishes. This may take considerable time in large plants, but the process is continually going on; and it is what occurs in plants growing in an overwet soil. In an open, well-aërated soil, on the other hand, even though it be apparently very dry, the root-hairs multiply and develop an astonishing power to find and absorb water; and a healthy, well-rooted plant can take up water from a soil which is to all appearance air-dry; whereas a plant which has not had time to develop its root-hairs in sufficient numbers to take in the firmly adherent water-films from numerous particles of soil would droop and wither. Soils are suitable for particular plants or not, according as they can or not, under the circumstances, afford the air at the roots that the plants need. Many plants flourish in an open soil with plenty of sand in it, but will not grow in a stiff, wet soil. The heavier soil is unfavorable, not necessarily because it does not contain the right food-materials, but because its particles are so small, so closely packed, and so retentive of moisture, that the root-hairs do not obtain sufficient oxygen. Root-hairs and roots can not grow or act unless the temperature is favorable; and a close, wet soil may be too cold for the roots at a time when an open, drier soil (exposed to similar conditions as regards sunshine, etc.) would have a degree of warmth favorable to their growth. The opening up of stiffer soils by the various processes in use is to be regarded as a means of letting in air, and therefore oxygen, to the roots.

The Cost of wasting Coal.—Prof. Chandler Roberts estimates the weight of the smoke-cloud which daily hangs over London at about fifty tons of solid carbon, and two hundred and fifty tons of carbon in the form of hydrocarbon and carbonic-oxide gases. Calculated from the average result of tests made by the Smoke Abatement Committee, the value of coal wasted from domestic grates reaches, upon the annual consumption of five millions of people, to £2,257,500. The cost of cartage on this wasted coal is calculated to be £268,750; while the unnecessary passage of about 1,500,000 horses through the streets in drawing it adds very seriously to the cost of street cleaning and repairing. Then there is the cost of taking away the extra ashes, £43,000 a year. Summing it all up, the direct and indirect cost of the wasted coal may be set down at £2,600,000, plus the additional loss from the damage done to property caused by the smoky atmosphere, estimated by Mr. Chadwick at £2,000,000—the whole amounting to £4,600,000, or $23,000,000.

Wolf-nursed Children.—In "An Account of Wolves nurturing Children in their Dens," published in 1852, by Colonel Sleeman, an experienced officer of the Indian army, are recorded a number of such cases as are indicated in the title. In one instance, near Sultanpoor, in 1847, a wolf was seen to leave her den, followed by three whelps and a little boy. The boy went on all-fours, and ran as fast as the whelps could. He was caught with difficulty, and had to be tied to keep him from rushing into holes and dens. He was alarmed when grown-up persons came near him, and tried to steal away. But if it was a child, he would rush at it with a fierce snarl, like a dog's, and try to bite it. He rejected cooked meat, but seized raw meat greedily, put it on the ground under his hands, like a dog, and ate it with evident pleasure. He would not let any one come near him while he was eating, but made no objection to a dog coming and sharing his food with him. He died in August, 1850, and after his death it was remembered that he had never been known to laugh or smile. He used signs when he wanted anything, but very few of them except when hungry, and then pointed to his mouth. When his food was placed at some distance from him, he would run to it on all-fours, but at other times he would occasionally walk upright. He shunned human beings, and seemed to care for nothing but eating.

Consanguineous Marriages.—Dr. Shuttleworth some time ago communicated to the British Medical Association the results of the inquiries which he had made into the influence of consanguineous marriages on offspring. For want of a uniform basis for comparison, positively accurate conclusions are hard to reach. His opinion on the subject, generally expressed, is that "first-cousin marriages are to some extent favorable to the production of idiot children." Extending his inquiries to the life-histories of the parents, he found that in the greater number of cases causes of idiocy could be discovered in addition to or independently of consanguinity. This is in harmony with the conclusion published by Dr. C. F. Withington, that morbid inheritance rather than specific degenerative tendency will account for all the infirmities met with in the offspring of cousins. We may therefore assume that "the great danger in the intermarriage of cousins lies in the circumstance that when there is a neurotic inheritance, there are two certain morbid factors to contend with rather than a possible one." On the whole, "the balance of evidence would appear to be in favor of the conclusion that where a close scrutiny fails to discover any heritable weakness, neurotic or otherwise, consanguineous marriage *per se* is not necessarily a thing to be prohibited."

The Senses of Animals.—In a lecture on "The Sense and Senses of Animals," Sir John Lubbock, after relating his experiments in teaching his dog to read, and another experiment from which he concluded that the dog could not distinguish color, said that he had always felt a great longing to know how the world appeared to the lower animals. It was still a doubtful point whether ants were able to hear. He had concluded, from his experiments, that they had not the power of addressing each other. His impression, on the whole, was that bees and ants were not deaf, but that they heard sounds so shrill as to be beyond our hearing. There was no doubt about insects seeing. The colors of objects must present a very different impression upon insects from that on human beings. The world to them might be full of music which we could not hear, colors we could not see, and sensations which we could not feel.

The History of a New Britain Papuan.—The Rev. George Brown, a missionary, gave in the British Association an account of the life-history of a native of the island of New Britain. When a child is born to the Papuan people of the country, a warm banana-leaf is wrapped around his body, and he is fed with the expressed juice of the cocoanut; ever after which he is left to be "dressed in pure sunshine." On the occasion of the marriage of the youth, there is an interchange of goods and a distinct payment for the wife. Presents are also given by the women to the bride, and by the men to the husband—a broom to the former and a spear to the latter—after which a stick is given to the man. The spear means that the husband must protect his wife, the broom that with it she must do her household work, and the stick is the symbol of the man's authority. In case of a death, the dead person is appealed to to come back, and is expostulated with for having left his friends, and entreated to say how his friends have offended him. The people have a definite idea of a future state, and of the punishment of one offender, the niggardly man. When an old man is about to die, he is placed upon a litter and carried round to see the scenes among which he has passed his life, and is then taken back to wait his time. After death the body is placed in a sitting posture and taken into the public square, with the man's weapons by his side, and the people place offerings of goods and money before it.

The Brazilian Barrancas.—Some of the upland regions of Brazil, especially near the city of Barbacena, are marked by the appearance of great rugged hollows in the sides and slopes of many of the rolling, grass-covered hills. They are land-slips, caused by the existence of springs, and present an appearance picturesque in the extreme. Their sides are worn into every imaginable shape, of pinnacles, domes, pointed towers, buttresses, and cavities, with ravines narrow, deep, and precipitous, or wide, open spaces, surrounded by lofty perpendicular walls, riven by creeks, and ready to fall. But their great charm lies in their color. The prevailing tint is a deep Indian red, which, combined with the green hills and the blue sky, bearing its glistening white clouds, constitutes a charming combination of tones. Any one of these barrancas, as they are called, offers excellent opportunities to the geologist. In many of them are found lying upon beds of sandstone, near the floor of the hollow, extensive deposits of fine laminated clays, varying in thickness, but frequently divided into layers like sheets of paper, with varieties of colors, pink, blue, white, black, gray, orange, crimson, purple, and yellow, lying side by side. Prof. Agassiz described precisely similar formations in the valley of the Amazon. Many of these barrancas show an upper stratum of white or yellow quartz conglomerate exceedingly rich in gold; and gold can often be got out of the surrounding earth from the top to the bottom of the sides, the hill being, as it were, literally "peppered" with the precious metal.

Mingrelian Rituals.—The people of Mingrelia, in the Caucasus, although professedly Christians, are, according to Freiherr von Guttner, addicted to practices and sacrifices that smack of heathenism. Offerings are established for all kinds of occasions, which every countryman can tale off on his fingers at will. Days are set for services to insure the protection of live-stock against disease. The most imposing of these is in behalf of the horse. Cakes are baked, on which is impressed the image of a horse or horseshoe, and are cast into a hollow tree, drenched with wine and blessed by the priest, while the participants in the sacrifice hop around the tree and imitate the capering and neighing of horses. In case a person has the measles, he and his attendants are dressed in red and the room is hung with the same color and adorned with red flowers, while care is taken not to irritate the demon by using a cutting instrument or admitting a dog. For diseases of the eye, little round cakes are made furnished with inserted pupils to resemble an eye, and then swung before the eyes of the patient. The priests are cognizant of these offerings, and are said, in fact, to get the best part of the gifts.

Melting away of the Mongolian Loess.—The process by which caves, sink-holes, and ravines are slowly formed in limestone has been observed by M. Potanin as going on rapidly in the loess of Mongolia. The loess is moved by water, and transported from higher to lower regions with about the same facility and steadiness as the shifting sands are moved by the wind. The underground water which filtrates through it begins by making in it a kind of cavern; then a circular crevice appears on the surface over the cavern, and a cylindrical vertical hollow, which soon becomes a deep well, is formed through the thickness of the upper layers of the formation. The whole surface of the loess deposits is dotted with such wells, which are very dangerous to cattle. By and by the formerly cylindrical well begins to extend in the direction in which the underground water flows, and a narrow ravine grows until it joins the main valley. The ravine continually increases in width by falls of new masses of loess, and the whole is steadily carried "down-stream" by the water.

How a Desert was made Productive.—Dr. G. V. Poore has told the way in which the Landes of France have been reclaimed and made habitable by carrying out the plans first applied by Bremontier at about the beginning of this century. By reason of the light character of the sands of the region, and its exposure to the powerful winds of the Bay of Biscay, its drainage presented special difficulties, which could not be overcome by the ordinary resources of engineering. Recognizing that it was useless to contend against the forces of nature, Bremontier determined to try to make use of them for the accomplishment of his purpose. Knowing the virtues of planting and promoting the growth of a network of roots, he planted a tract of the dunes with peas, which would grow in the sand and send their roots to a considerable depth; and, for more permanent effect, with the maritime pine. The pine-seeds were sown mixed with seeds of the common broom, whose shrubs might serve as nurse-plants to the infant pines, and the sowings were made in a direction at right angles to the prevailing wind. A screen of hurdles made of gorse or of planks deeply driven into the sand was placed on the windward side of the seed-ground, and the seed-ground itself was thatched with pine-branches and other suitable material. In the course of time the brooms reached their full growth, while the pines continued to grow, overtopped them, and crowded them out. The maritime pines have grown well and have proved a very profitable tree, yielding moderately good timber and much turpentine; in addition to which a good business is done in charcoal. Thus the waste moorlands on the shores of the Bay of Biscay have become of great commercial value. The railway journey of four or five hours from Bordeaux to Bayonne is now made through a long, monotonous pine-forest. The cultivation of the pine improves the soil, which is gradually enriched and altered in quality by the dead leaves and other vegetable *débris* which fall upon it. In some places clearings have been made in the forests and vineyards planted.

The Colorado Oil-Field.—According to Prof. Newberry's description in the American Association, the oil-field recently discovered in Colorado is situated in the valley of the Arkansas, above Pueblo, about the town of Florence. The geological formation is middle cretaceous, the Laramie coal series (upper cretaceous) forming the table-land on either side of the valley, the oil-wells being bored in the Colorado shales (middle cretaceous). These shales are highly carbonaceous, and have a thickness of about three thousand feet. About twenty wells have been bored, mostly to the depth of from eleven to sixteen hundred feet; some fourteen are now pumping, and yield from eight hundred to a thousand barrels per day. The oil is of excellent quality, has a green color, and an agreeable odor. It yields on distillation forty per cent of excellent burning-fluid, and nearly sixty per cent of superior lubricating oil, which contains much more paraffine than the oil of Pennsylvania. The average yield of the wells is nearly sixty barrels. This is larger than the average yield of the Pennsylvania wells, but there are no great "gushers" or fountain-wells. The oil-field of the Arkansas Valley is extensive, and the yield of oil may apparently be increased indefinitely. At present there is no sale for the lubricating oil, but, when an outlet is opened to that by way of the Gulf of Mexico, the oil industry may be expected to become very important and remunerative. The source of the oil is undoubtedly the carbonaceous matter of the Colorado black shale, from which it is being spontaneously distilled.

Deaths by Wild Beasts in India.—Conditions of peril from wild beasts and snakes exist in India of which it is hard to form an adequate conception in a country like ours. The death-list from these causes has, during the last four years, averaged more than 22,500. Of 22,817 deaths in one of these years, 20,142 were caused by snakes, leaving 2,675 to be ascribed to wild beasts. Last year's returns also mention 60,000 head of cattle as killed by these agencies, of which snakes were, however, responsible for only 2,000, while 20,000 each were ascribed to leopards and tigers. The apathy of the natives in the face of this destruction would be astonishing to a Westerner, as would also their remissness in clearing out places where these nuisances abound.

NOTES.

The article on "Bird Courts of Justice" in the last number of the "Monthly" should have been credited to "Chambers's Journal," from which it was, with a few adaptations and abbreviations, compiled.

Committees were appointed by the American Association at its Cleveland meeting as follows: Committee on Chemistry Teaching—W. H. Seaman, W. L. Dudley, H. W. Wiley, W. O. Atwater, and W. A. Noyes; Committee on Water Analysis—O. C. Caldwell, J. W. Langley, J. A. Myers, W. P. Mason, R. B. Warder, and W. H. Seaman; Committee to confer concerning the Organization of a National Chemical Society—A. B. Prescott, Alfred Springer, and Edward Hart. Dr. A. B. Prescott was substituted for Dr. Scudder on the Committee on indexing Chemical Literature.

In a paper read by Dr. Franz Boas before the American Association, on "The Development of the Civilization of the North American Indian," the legends of the various tribes are discussed, and it is shown that, notwithstanding their general similarity, the mythology of each tribe is founded on a separate basis. Thus it is shown that the common culture of the tribes of the northwest coast of America is not uniform, and the influence of one of them is more particularly traced. This culture should be analyzed more carefully before any comparisons with Asiatic and Polynesian tribes can be successfully made.

Prof. B. E. Fernow, having shown in the American Association that the prevailing definitions of a tree—as distinguished from a shrub—are various and inexact, proposed this: "Trees are woody plants, the seed of which has the inherent capacity (potential energy) of producing naturally within their field of distribution one main, erect axis (single stem or trunk), not divided at or near the ground (bearing a crown), the primary axis continuing to grow for a number of years more vigorously than the lateral axis, and the lower branches dying off in time."

STEPS were taken at the recent meeting of the American Association for the formation of an American Geological Society. A constitution was adopted, under which the society will consist of not less than a hundred Fellows, and will meet annually during the Christmas holidays, with a second meeting in connection with that of the American Association. The committee under whose charge this action was taken, of which President Alexander Winchell is chairman, was continued as a committee to secure members.

FROM examinations of certain waters—one of them being a "mineral" water free from all possible sources of contamination—in which free ammonia was present—Prof. E. H. S. Bailey remarked, in the American Association, that he was inclined to consider that that substance may be sometimes a natural constituent, and not indicative of any pollution, of the water.

AUSTRALIAN experiences prove it bad policy to offer scalp-bounties for the destruction of animal pests. Such bounties have been offered for the rabbit pest, and, encouraged by them, a class of professional rabbit-hunters has sprung up, who carefully nourish the supply of their profitable game, and see that the natural enemies of the rabbits, which might do a great deal to limit their increase, are kept down.

A STUDY has been made by Prof. T. G. Bonney of the rounding of pebbles by the Alpine torrents and rivers. From this it appears that pebbles are rounded with comparative rapidity when the descent of the stream is rapid, and they are dashed down rocky slopes by a roaring torrent capable of sweeping along blocks of much greater volume; while the rounding takes place with comparative slowness when the descent is gentle and the average fall of the river is about adequate to push them along in its bed.

THE International Congress of Americanists, which meets in Berlin October 2d to 5th, will discuss, on the first day, questions relating to the discovery of the New World, to the history of America before the time of Columbus, and to American geology; the second day, subjects of archæology; the third day, those of anthropology and ethnology; and the fourth day, philology and palæography.

COMPARATIVELY little attention was given by the medical profession to the treatment of sprains till in 1870 or 1871, when Sir James Paget urged the investigation of the subject and the institution of scientific methods in the matter. Dr. Wharton Hood afterward published in the "Lancet" an account of the methods followed by the professional bone-setters of the public, which, with some blunders, were attended with considerable success. A full treatise on the subject has recently been published in London by Dr. G. W. Mansell Moulin. This author recommends a treatment chiefly hydropathic, with the avoidance of such lotions and liniments as arnica and rhus toxicodendron; an accurately measured rest, followed by moderate and careful movements, and suitably adapted massage.

PARASITIC fishes—extremely small beings, shaped like an eel—have been recognized only for a relatively short time. Ten species have been distinguished in different seas and oceans. They usually attach themselves to some hollow part of the bodies of marine animals, preferably entering the respiratory cavities of star-fish. They have even been found in the interior of the shells of pearl-oysters. They do not injure the animals with which they associate themselves, for they do not live upon them, but upon the minute organisms which the sea-water brings to their cavities, so that they are really commensals rather than parasites.

THE property which platinum and palladium display of throwing off flakes of their substance when under the influence of a strong electric current is due to the gases which they have occluded. Gold exhibits it in a less degree, and it may be that the old experiment of exploding wires by the discharge from Leyden-jar batteries depends upon the outbursts of occluded gases. The same property of occlusion exists in carbon, and has to be taken account of in the manufacture of incandescent lamps, from the wicks of which the gases must be driven out previous to using, else there will be no durability to them.

MR. MARIES, superintendent of the gardens of the Maharajah of Durbunga, India, has succeeded in reclaiming a tract of waste saline soil, in which not even weeds would grow, by digging down to the depth of two feet and planting thickly at the beginning of the rainy season with trees that had been grown in pots. In three years the ground was filled with roots, and to all appearances the salt had gone. When the trees were thinned out in 1887, the soil was found to be in good condition. Similar experiments have been successfully carried out in other places. Various kinds of trees were employed in the reclaiming operations, but the best were the *Inga saman*, or rain-tree, and the *Albizzia procera*.

LAST year's coroners' inquests in England furnished two examples of death resulting from tight-lacing. The last case was of a young lady suffering from fatty infiltration of the heart, who died suddenly while dressing hastily after a hearty meal. The corset was proved to have had a close agency in determining the fatal result.

In a communication on injuries by lightning in Africa, Emin Pasha shows that in the central regions (from latitude 2° to 6° north) they are of average frequency, while further north, as at Fashoda, Khartoum, and Berber, they are nearly unheard of. A belief prevails among the Soudan Arabs that with every flash of lightning a piece of meteoric iron is thrown to the earth. They fancy that whoever is able to secure such a piece of iron has gained a great treasure, because swords and knives made from it can not be surpassed in quality, and their possession gives immunity from danger in battle, and protection against lightning-strokes. Sheik Narr, chief of the Takkala Mountains, is said to have resisted all Egyptian attacks, and to have preserved his people's independence, through the possession of such a sword.

Antipyrine, an artificial alkaloid obtained from coal-tar, is recommended by M. E. Dupuy and M. Ossian-Bonnet as a remedy for sea-sickness. M. Dupuy asserts that, administered for three days before embarking and during the first three days of the voyage, in doses of three grammes a day, it prevented sea-sickness during the voyage across the Atlantic. M. Ossian-Bonnet usually obtained effects in ten minutes from a dose of one and a half gramme, and in no case had to use more than three grammes in two doses. When the stomach would not hold the medicine, a subcutaneous injection was efficient.

M. de Chardonnet has artificially produced a substance having the apparent qualities of silk. He treats the ethereal solution of cellulose with a similar solution of perchloride of iron or perchloride of tin, and, adding an alcoholic solution of tannic acid, obtains a substance that can be drawn out into a thread. These threads, which may be spun into stronger cords, are supple, transparent, and cylindrical or flattened; silky to the look and the touch; break with a weight of twenty-five kilogrammes per square millimetre; burn without the fire extending; are slowly decomposed by heating; are not acted upon by acids and alkalies of moderate degrees of concentration, water, alcohol, or ether; but are dissolved in etherated alcohol and acetic ether.

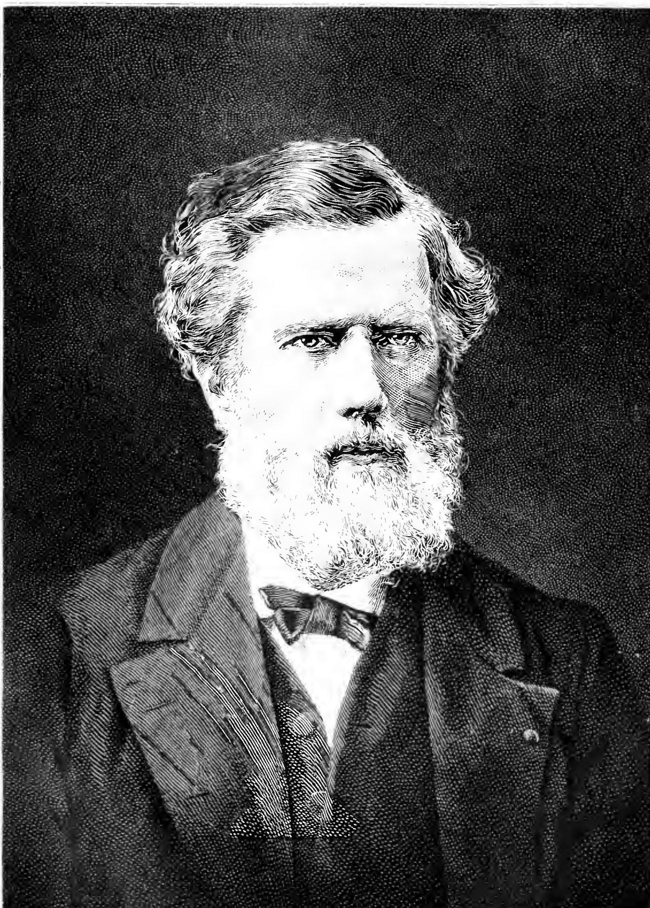
The Belgian Government, after experiments to ascertain the best methods of making the clothing of its soldiers water-proof, has adopted that of bathing the goods in acetate of alumina, and then drying them in the air, without wringing. The doctors have expressed the opinion that clothing thus prepared offers no obstacle to perspiration, and is therefore hygienically unobjectionable. It appears also to be determined that the goods are not depreciated either in quality or color by the preparation. The only serious objection to the process is its cost.

While the question of the origin of the Aryans is under discussion, Mr. G. Bertin suggests that we may learn something of it by looking further than we have yet done into the roots of their languages. Even in the oldest specimens they bear evidence of being hybrids—in inconsistencies of syntax; in the promiscuous use of prepositions and postpositions; in having many words and roots to express the same objects; and in the use of three genders. Hence the original tongue may have been a fusion of two languages—say of Accadian or some closely related speech and some Semitic language. The supposition is supported by the fact that a great many resemblances have been observed between Accadian and Sanskrit.

A new view of fetichism is taken by Major A. B. Ellis, in his book on the "Tshi-speaking Peoples of the Gold Coast." He does not think it characteristic of primitive peoples, or of races low in the scale of civilization, but believes that it is arrived at only after considerable progress has been made in religious ideas, when the older form of religions becomes secondary. And "it owes its existence to the confusion of the tangible with the intangible, of the material with the immaterial; to the belief in the indwelling god being gradually lost sight of, until the power, originally believed to belong to the god, is finally attributed to the tangible and inanimate object itself."

Some recent comparative analyses, made at Dundee, Scotland, of the air of sewers and that of the close rooms of some of the well-inhabited houses of the city, turned out to the advantage of the sewers. That is, the analysts found in small and ill-ventilated houses more carbonic acid, more organic matter, and far more micro-organisms than in the sewer-air they examined; so that, if the experiments were to be taken as final and conclusive, the inhabitants of a small room would improve their position by living in the atmosphere of a sewer! The experiments are, of course, not to be thus taken; but it is easy to conceive of cases in which the inference would be correct. The lesson to be drawn from it would be, not that sewer-air is less dangerous than it is thought to be, but an admonition of the necessity for improving the sanitary condition of some houses.

The Zirknitzen Lake in central Carniola, according to Herr Putik's description, exhibits remarkable phenomena of periodical emptying and filling. A gigantic cave, called Gilovca or Karlovca by the natives, and situated at the northwest corner of the lake, forms an outlet for the overflow. It lies at the foot of perpendicular rocks, and leads to a number of subterranean lakes, five of which Herr Putik has crossed.



F. A. VULPIAN

THE

POPULAR SCIENCE

MONTHLY.

DECEMBER, 1888.

THE PSYCHOLOGY OF DECEPTION.

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THE saying that appearances are deceptive is an inheritance from very ancient times. To Oriental and to Greek philosophers the illusory nature of the knowledge furnished by the senses was a frequent and a fertile theme of contemplation and discussion. The same problem stands open to the psychologist of to-day; but, profiting by the specialization of learning and the advance of technical science, he can give it a more comprehensive as well as a more practical answer. The physiological activities underlying sense-perception are now well understood; the experimental method has extended its domain over the field of mental phenomena; and in every way we have become more expert in addressing our queries to the sphinx, Nature, so as to force a reply. To outline the position of modern psychology with reference to this interesting problem of deception is the object of the present essay.

In a sensation we recognize a primitive element in the acquisition of knowledge. The deprivation of a sense results in a dwarfed and incomplete mental development. This is due, not to the mere sense-impressions that the organ furnishes, but to the perception and co-ordination of these by inferential processes of the higher faculties. It is not the eye of the eagle, but the brain directing the human eye, that gives intellectual supremacy. Physiology recognizes this distinction as one between lower and higher brain-centers. A man may lose his retina, or may have his optic nerve injured, and so be blind in the ordinary sense of the word. He is prevented from acquiring further knowledge by this avenue; but, unless he become blind in early childhood, he will retain a good memory for visual images, will be able to more or less clearly imagine pictorially the appearances of objects from verbal descriptions, and in the free roamings of his dream fancy will live in a world in which blindness is unknown. On the other hand, cases occur where, owing to the disordering of certain portions of the finely organized cortex of the brain, the patient, though retaining full sight and understanding, is unable to derive any meaning from what he sees. The same group of sensations that suggest to our minds a book, a picture, a face, and all the numerous associations clustering about these, are as unmeaning to him as the symbols of a cipher alphabet. This condition is termed "psychic blindness," and what is there lost is not the power of vision, but of interpreting, of assimilating, of reading the meaning of visual sense-impressions.

In the experiences of daily life we seldom have to do with simple sensations, but with more or less complex inferences from them; and it is just because these inferences go on so constantly and so unconsciously that they are so continually and so persistently overlooked. It has probably happened to the reader that, upon raising a pitcher of water which he was accustomed to find well filled, the vessel has flown up in his hand in a very startling manner. The source of the difficulty was the emptiness of the pitcher. This shows that one unconsciously estimates the force necessary to raise the vessel but only becomes conscious of this train of inference when it happens to lead to conclusions contradictory of the fact. The perception of distance, long thought to be as primitive a factor in cognition as the impression of a color, is likewise the result of complex inferences; and the phenomena of the stereoscope furnish unending illustrations of the variety and complexity of these unconscious reasonings. These, it must be noted, are drawn by all persons alike; but, like the man who was unaware that he had been talking prose all his life until so informed, are not recognized as such until special attention is directed to them.

The simplest type of a deception occurs when such an inference owing to an *unusual disposition of external circumstances*, leads to a conclusion which other and presumably superior testimony shows to be false. A typical case is the observation, described already by Aristotle, that a ball or other round object held between two fingers crossed one over the other, will seem double. Under ordinary circumstances a sensation of contact on the left side of one finger and on the right side of the finger next to it (to the right) could only be produced by the simultaneous application of two bodies. We unconsciously make the same inference when the fingers are crossed and thus fall into error—an error, it is important to observe, which we do not *outgrow* but *antagonize* by more convincing evidence. Again, the stimulation of the retina is ordinarily due to the impinging upon it of light-waves emanating from an external object. Accordingly, when the retina is disturbed by any exceptional cause, such as a blow or electric shock, we have a sensation of light projected outward into space. In brief, we are creatures of the average; we are adjusted for the most probable event; our organism has acquired the habits impressed upon it by the most frequent repetitions; and this has induced an inherent logical necessity to interpret a new experience by the old, an unfamiliar by the familiar. As Mr. Sully well expresses it, these illusions "depend on the general mental law that when we have to do with the unfrequent, the unimportant and therefore unattended to, and the exceptional, we employ the ordinary, the familiar, and the well known as our standard." Illusion arises when the rule thus applied fails to hold; and whether or not we become cognizant of the illusion depends upon the ease with which the exceptional character of the particular instance can be recognized, or the inference to which it leads be opposed by presumably more reliable evidence.

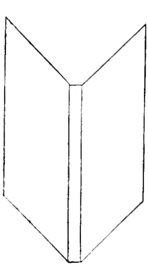
As our present purpose is to investigate the nature of real deception, of the formation of false beliefs leading to erroneous action, it will be well to note that even such elementary forms of sense-deceptions as those just noted fall under this head. No one allowed the use of his eyes will ever *believe* that the ball held between the crossed fingers is *really* double, but children often think that a spoon half immersed in water is *really* bent. Primitive peoples believed that the moon *really* grew smaller as it rose above the horizon, and the ancients could count sufficiently upon the ignorance of the people to make use of mirrors and other stage devices for revealing the power of the gods. The ability to correct such errors depends solely upon the possession of certain knowledge, or a confidence in the existence of such knowledge.

Still confining our attention to deceptions produced by exceptional external arrangements, let us pass to more complex instances of them. These, as so many of the types of deception, are found in great perfection in conjuring tricks. When ink is turned into water and water into ink; when a duplicate coin or other article is skillfully introduced in place of the one that has disappeared; when two half-dollars are rolled into one; when a box into which you have just placed an article is opened and found to be empty; when the performer drives a nail through his finger, or when a card which you have just assured yourself is the ace of hearts on second view becomes the king of spades—you are deceived because you are unaware that the addition of a chemical will change the color of liquids; that the piece you now see is different from the one you saw a moment ago; that the one half-dollar is hollow and the other fits into it; that the box has a double bottom; that the nail has been substituted for one that fits around the finger, and that one half of the card is printed on flap which by falling down shows another aspect. All these are technical devices which amuse us by the ingenuity of their construction and provoke about the same kind of mental interest as does a puzzle or an automaton. Ignorance of this technical knowledge or lack of confidence in its existence may convert these devices into *real deceptions* by changing the mental attitude of the spectator. However, the plausibility of such performances depends so much upon their general presentation that they seldom depend for their effectiveness *solely* upon the objective appearances they present. Asking the reader, then, to remember the very great number and ingenuity of such devices, and insisting once more that the only complete safeguard against being deceived by them is the acquisition of the purely technical knowledge that underlies their success, I will cite in detail a trick combining illustrations of several of the principles to be discussed. A number of rings are collected from the audience upon the performer's wand. He takes the rings back to the stage and throws them upon a platter. A pistol is needed, and is handed to the performer from behind the scenes. With conspicuous indifference he hammers the precious trinkets until they fit into the pistol. A chest is hanging on a nail at the side of the stage. The pistol is fired at this chest, which is thereupon taken down and placed upon a table toward the rear of the stage. The chest is unlocked and found to contain a second chest. This is unlocked and contains a third; this a fourth. As the chests emerge they are placed upon the table; and now from the fourth chest there comes a fifth, which the performer carries to the front of the stage and shows to contain bonbons, around each of which is tied one of the rings taken from the audience. The effect is indescribably startling. Now for the real *modus operandi*. In the hand holding the wand are as many brass rings as are to be collected. In walking back to the stage the genuine rings are allowed to slip off the wand and the false rings to take their places. This excites no suspicion, as the walking back to the stage is evidently necessary, and never impresses one as part of the performance. The pistol is not ready upon the stage, but must be gone for, and as the assistant hands the performer the pistol, the latter hands the assistant the true rings. The hammering of the rings is now deliberately undertaken, thus giving the assistant ample time to tie the rings to the bonbons, and, while all attention is concentrated upon the firing of the pistol, the assistant unobtrusively pushes a small table on to the rear of the stage. This table has a small fringe hanging about it, certainly an insignificant detail, but none the less worth noting. The chests are now opened, and, after having shown the audience that the second chest comes out of the first, the third out of the second, and so on, he can very readily and quickly draw the last smallest chest from a groove *under* the table and bring it out as though it *had come* out of the next larger chest. This is opened and the trick is done. So thoroughly convinced is the observer by the correctness of his first three inferences that the last box came out of the one before it, that I venture to say this explanation never occurred to one in ten thousand, and that most of the audience would have been willing to affirm on oath that they saw the last box so emerge. The psychology of the process, then, consists in inducing the spectator to draw the natural logical inference, which in this case will be a wrong one.

The more closely the conditions that lead to correct inferences in ordinary experience are imitated, the more successful will be the illusion; and one great principle of conjuring illusions is to *first actually do* that which you *afterward* wish the audience to *believe you have done.* Thus, when coins are caught in mid-air and thrown into a hat, a few are really thrown in; but the others palmed in the hand holding the hat, and allowed to fall in when the other hand makes the appropriate movements. Some of the rings to be mysteriously linked together are given to the audience for examination and found to contain no opening, the audience at once concluding that the rings which the performer retains are precisely like them. In general, to gain the confidence of the person to be deceived is the first step alike in sleight of hand and in criminal fraud.

As we turn from the objective to the subjective conditions of deception, we enter the true domain of psychology; for the most scientific deceiver is he who employs least external aids, and counts most upon his power of captivating the intellect. Just as we interpret appearances by the forms they most commonly assume, so it is our average normal selves that interpret them. A variation in our sense-organs or our judging powers will lead to illusion. The effects of contrast are an apt illustration. Coming from a dark to a light room, the light seems glaringly bright; a hand immersed in hot water and then in lukewarm water will feel the latter as cold; when accustomed to the silence of the country the bustle of the city seems unusually noisy, and so on. Fatigue produces similar results. Fatigue the eye for red, and it sees white light as green; the last mile of a long walk seems the longest; the last hour of a long wait, the most tedious. So long as we recognize our unusual condition and allow for its effects, we are not deceived; but under the influence of emotion this power is easily lost. The delusions of the insane are often misinterpretations of abnormal sensations under the guidance of a dominant idea. One patient, with abnormal skin-sensibility, believes he is made of glass or stone; another, for similar reasons, believes he has an invisible persecutor constantly at his side. But for the present we will assume that the judging powers do not vary beyond their normal limits.

In every perception two factors contribute to the result. The one is the nature of the object perceived, the other that of the percipient. The effect of the first factor is well recognized, the importance of the second factor is more apt to be overlooked. The sunset is a different experience to the artist from what it is to the farmer; a piece of rocky scenery is viewed with quite different interests by the artist and the geologist. The things that were attractive in childhood have lost their charm, and what was then considered stupid, if noticed at all, has become a cherished hobby. Even from day to day our interests change with our moods, and our views of things brighten with the weather or the good behavior of our digestive organs. Not only will the nature of the impression change with the interests of the observer, but even more, *whether or not* an object will be *perceived at all* will depend upon the same cause. The naturalist sees what the stroller entirely overlooks; the sailor detects a ship in the distant horizon where the landsman sees nothing; and this is not because the naturalist and the sailor have keener vision, but because they know what to look for. Whenever an impression is vague or an observation made under poor conditions, this subjective element comes to the front. The vague and changing outline of a cloud is "almost in shape of a camel," or "like a weasel," or "like a whale." Darkness, fear, any strong emotion, any difficulty in perception show the same thing. "La nuit tous les chats sont gris." Expectation, or expectant attention, is doubtless the most influential of all such factors. When awaiting a friend, any indistinct noise is readily converted into the rumbling of carriage-wheels; the mother hears in every sound the cry of her sick child. After viewing an object through a magnifying-glass, we detect details with the naked eye which escaped our vision before. When the answer in the book happens to be wrong, nine tenths of the students will be able to get it none the less. We can regard the accompanying outline either as a book with the back protruding toward us or receding from us.



Everywhere we perceive what we expect to perceive, in the perception of which we have an interest. The process that we term sensation, the evidence of the senses, is dual in character, and depends upon the eyes that see as well as upon the things that are seen.

Accordingly, the conjurer whose object it is to deceive does so by creating an interest in some unimportant detail, while he is performing the real trick before your eyes without your noticing it. He looks intently at his extended right hand, involuntarily carrying your eyes to the same spot while he is doing the trick with the unobserved left hand. The conjuror's wand is extremely serviceable in directing the spectator's attention to the place where the performer desires to have it.* So, again, when engrossed in work, we are oblivious to the knock at the door or the ringing of the dinner-bell. An absent-minded person is one so entirely "present-minded" to one train of thought that other impressions are unperceived. The pickpocket is psychologist enough to know that at the depot, the theatre, or wherever one's attention is sharply focused in one direction, is his best opportunity for carrying away your watch. It is in the negative field of attention that deception effects its purpose. Houdin gives it as one of his rules never to announce beforehand the nature of the effect which you intend to produce, so that the spectator may not know where to fix his attention. He also tells us that whenever you count "*one, two, three*," as preliminary to the disappearance of an object, the real vanishing must take place before you say "three," for the audience have their attention fixed upon "three," and whatever is done at "one" or "two" entirely escapes their notice. The "patter" or setting of a trick is often the real art about it, because it directs or rather misdirects the attention. When performing before the Arabs, Houdin produced an astounding effect by a very simple trick. Under ordinary circumstances the trick was announced as the changing of the weight of a chest, making it heavy or light at will. The mechanism was simply the attaching and severing of a connection with an electro-magnet. To impress the Arabs, he announced that he could take a man's strength away and restore it again at a moment's notice. At one time the man could raise the chest with ease, but the next he would not have power enough to move it an inch. The trick succeeded as usual, but was changed from conjuring to sorcery—the Arabs declaring him in league with the devil.

The art of misleading the attention is recognized as *the* point of good conjuring, the analogues of the diplomacy that makes the object of language to conceal thought; and a host of appropriate illustrations might be derived from this field. The little flour-

* "Again, a mere tap with the wand on any spot, at the same time looking at it attentively, will infallibly draw the eyes of a whole company in the same direction"—*Houdin.* Robert Houdin, often termed "the king of the conjurers," was a man of remarkable ingenuity and insight. His autobiography is throughout interesting and psychologically valuable. His conjuring precepts abound in points of importance to the psychologist, and a reference to his writings will well repay the reader.

ishes, tossing an object up in the air, "ruffling" or "springing" a pack of cards, a little joke—all these create a favorable opportunity, a "temp," when the attention is diverted and the other hand can reach behind the table or into the "pocket." These points would lead us too far, and perhaps it will suffice to analyze the points of interest in the "chest and ring trick" described above. Here the moment for the exchange of the rings is the one which is least suggestive of being a part of the performance, and therefore least attended to. The preparations for the shooting absorb the attention and allow the introduction of the small table at the rear to pass unnoticed; while the series of drawings of the chests so entirely prepare the spectator for the appearance of the last chest from the one preceding, that he actually sees the chest emerge from where it never was.

There is, however, one important factor lacking in the conjurer's performance to completely illustrate the psychology of deception. It is that the mental attitude of the observer is too definite. He knows that he is being deceived by skill and adroitness, and rather enjoys it the more he is deceived. He has nothing at stake, and his mind rests easy without any detailed or complete explanation of how it was done. Quite different must have been the feeling of the spectator before the necromancer of old, in whose performance was seen the evidence of secret powers that could at a moment's notice be turned against any one to take away good luck, bring on disease, or even transform one into a beast. When magic spells and wonder-working potions were believed in, what we would now speak of as a trick was surrounded with a halo of awe and mystery by the sympathetic attitude of the spectators. The most complete parallel to this in modern times is presented by the physical phenomena of spiritualism.* This is a perfect mine for illustrations of the psychology of deception, and it is this that I will consider as the final topic in this cursory view.

The first general principle to be borne in mind is that the medium performs to spectators *in doubt* as to the interpretation to be placed upon what they see, or more or less determined to see in everything the evidence of the supernatural. This mental attitude on the part of the spectators is *worth more to the medium* than any facts in the performance. The difference between such a presentation and one addressed to persons cognizant of the conjuring element in the performance, and bent upon its detection,

* For the present purpose it is necessary to select only such spiritualistic phenomena as have conclusively been proved to be producible by trickery, and to have been accepted as evidences of spiritual agency, without disposing of the problems of spiritualism in the least. Personally, I believe all the phenomena explicable by the same physical and psychological principles that have divested so many of them of their mystery.

can not be exaggerated. It is this that makes all the difference between the *séance* swarming with miracles, any one of which completely revolutionizes the principles of science, and the tedious dreariness of a blank sitting varied only by childish utterances and amateurish sleight of hand. Scientific observers often report that the very same phenomena that were utterly beyond suspicion in the eyes of believers, are to unprejudiced eyes so apparent "that there was really no need of any elaborate method of investigation"; close observation was all that was required. Again, Mr. Davies, of the English Society for Psychical Research, has experimentally shown that, of equally good observers, the one who is informed of the general *modus operandi* by which such a phenomenon as "slate-writing" is produced, will make much less of a marvel of it than one who is left in doubt in this regard.

With these all-powerful magicians, an expected result, and the willingness to credit a marvel clearly in mind, let us proceed from those instances in which they have least effect up to the point where they form the chief factor. First come a host of conjuring tricks performed on the stage in slightly modified forms, but which are presented as spiritualistic. So simple a trick as scratching a name on one's hand with a clean pen dipped in water, and then rubbing the part with the ashes of a bit of paper containing the name, thus causing the ashes to cling to the letters formed on the hand and reveal the mystic name, has been offered as a proof of spirit agency. Whenever an article disappears or rapidly changes its place, the spiritualist is apt to see the workings of hidden spirits; and over and over again have the performances of professional conjurers been declared to be spiritual in origin in spite of all protest from the conjurers themselves. Here everything depends upon the possession of certain technical knowledge; judging without such knowledge is apt to be mere prejudice. Another very large class of phenomena consists of those in which the performer is placed in a position apparently inconsistent with his taking any active part in the production of the phenomena—rope-tying tests, cabinet *séances*, the appearance of a "spirit-hand" from behind a screen, locking the performer in a cage, sewing him in a bag, and so on. The psychologist has very little interest in these; their solution depends upon the skill with which knots can be picked, locks unfastened, and the other devices by which security can be simulated. The chief interest in such performances is the historical one, for these have done perhaps more than anything else to convince believers of the truth of spiritualism. Here, where everything depends upon the security of the fastenings (for once free, the medium can produce messages from the spirit-land limited only by his ingenuity and boldness), it might be supposed that all possible precautions had been taken against undoing them; while, as a matter of fact, the laxity of most investigators in this regard is well known. These performances deceive because people overlook the technical acquisitions needed to pronounce upon the possibility or impossibility of a fastening being undone and apparently restored without detection. If manufacturers of safes were equally credulous, and gave equally little time to the study of the security of locks, "a safe" would be an ironical expression indeed.

Passing next to the most interesting of spiritual manifestations, those in which self-deception comes to the foreground, I need hardly dwell at length upon the tilting of tables, the production of raps by movements of which the sitters are unconscious; for these have been so often and so ably presented that they must now be well understood. Suffice it to say that it has been objectively proved that it is almost impossible not to give some indication of one's thoughts when put upon the strain; and that, when excited, these indications may be palpably plain and yet remain unperceived by the individual who gives them. The extreme subtlety of these indications is met by the unusual skill of the professional "mind-reader," who takes his clew from indications which his subject is "absolutely confident he did not give." The assurance of sitters that *they know* they did not move the table is equally valueless, and here nothing but objective tests will suffice. The most wholesome lesson to be derived from the study of these phenomena is the proof that not all our intentions and actions are under the control of consciousness, and that, under emotional or other excitement, the value of the testimony of our consciousness is very much weakened. Again, it is almost impossible to realize the difficulty of accurately describing a phenomenon lying outside the common range of observation. Not alone that the knowledge necessary to pronounce such and such phenomenon impossible of performance by conjuring methods is absent, but with due modesty and most sincere intentions the readiness with which the observing powers and the memory play one false is overlooked. In the investigation of Mr. Davies, above referred to, the sitters prepared accounts of the "slate-writing" manifestations they had witnessed, and described marvels that they had not seen but which they were convinced they had seen—writing on slates utterly inaccessible by Mr. Davies, and upon slates which they had noticed a moment before were clean. The witnesses are honest; how do these mistakes arise? Simply a detail omitted here, an event out of place there, an unconscious insertion in one place, an undue importance to a certain point in another place—nothing of which any one need feel ashamed; something which it requires unusual training and a natural bent to avoid. The mistake lies in not recognizing our liability to such error.

If, however, the spectator is once convinced that he has evidence of the supernatural, he soon sees it in every accident and incident of the performance. Not only that he overlooks natural physical explanations, but he is led to create marvels by the very ardor of his sincerity. At a materializing *séance* the believer recognizes a dear friend in a carelessly arranged drapery seen in a dim light. Conclusive evidence of the subjective character of such perceptions is furnished by the fact that the same appearance is frequently recognized by different sitters as the spiritual counterpart of entirely different and totally dissimilar persons. A "spirit-photograph" is declared to be the precise image of entirely unlike individuals. Each one sees what he expects to see, what appeals to his interests the most intensely. What the unprejudiced observer recognizes as the flimsy, disguised form of the medium, the believer transforms into the object of his thoughts and longings. Only let the form be vague enough, the light dim enough, the emotions upon a sufficient strain, and that part of perception in which the external image is deficient will be readily supplied by the subjective tendencies of each individual. In the presence of such a mental attitude the possibilities of deception are endless; the performer grows bolder as his victim dispenses with tests, and we get scientific proofs of the fourth dimension of space, the possibility of matter passing through matter, the laws of gravity entirely set aside. And the identically same performance that would convince Prof. Zoellner of the reality of the fourth dimension of space, would show the spiritualist the workings of his deceased friends, would convince the theosophist of the spiritual flight of the performer's astral body, and (it may not be irrelevant to add) it is the same type of performance that served and yet serves to terrify the minds of uncultivated and superstitious savages. All depend not upon what is done, but upon the mind of the spectator. Little by little, through neglect, through mal-observation and lapses of memory, through an unwillingness to mistrust the reports of an excited consciousness, caution is abandoned, credulity enters, until mediums are actually seen flying out of one window and into another, until the wildest and most far-fetched fantastic explanation is preferred above a simple one; until the bounds of the normal are passed, real hallucinations set in, conduct becomes irrational, and a state not distinguishable from insanity ensues. If this seems improbable, turn back to the records of witchcraft persecutions and read upon what trifling and wholly imaginary evidence thousands of innocent lives were sacrificed; and this not by ignorant, bloodthirsty men, but by earnest, by eminent, by religious leaders. A child is taken sick, is remembered to have been fondled by an old woman; therefore the woman has put the child under a spell and must be burned. A man sees an old woman in the woods, and, on turning about, the old woman is gone and a hare flies across his track; he concludes that she turned herself into a hare, and the witch test is applied. When the personal devil was believed in, he was daily seen clothed in the garments that imagination had given him, and engaged in mischievous actions of all kinds. When witchery was the dominant superstition, all things gave evidence of that. With the doctrines of modern spiritualism to be supported, the number of mediums and manifestations will be correspondingly abundant. Create a belief in the theory, and the facts will create themselves.

In the production of this state of mind a factor as yet unmentioned plays a leading *rôle*: it is the power of *mental contagion*. Error, like truth, flourishes in crowds. At the hearth of sympathy each finds a home. The fanatical lead, the saner follow. When a person of nervous temperament, not strongly independent in thought and action, enters a spiritualistic circle, where he is constantly surrounded by confident believers, all eager to have him share their sacred visions and profound revelations, where the atmosphere is replete with miracles and every chair and table may at any instant be transformed into a proof of the supernatural, is it strange that he soon becomes one of them?—hesitatingly at first, and perhaps yet restorable to his former modes of thought by the fresh air of another and more steadfast mental intercourse, but more and more certainly and ardently convinced the longer he breathes the *séance* atmosphere. No form of contagion is so insidious in its onset, so difficult to check in its advance, so certain to leave germs that may at any moment reveal their pernicious power, as a mental contagion—the contagion of fear, of panic, of fanaticism, of lawlessness, of superstition. The story of the witchcraft persecutions, were there no similar records to deface the pages of history, would suffice as a standing illustration of the overwhelming power of psychic contagion. To fully illustrate its importance in the production of deception would require an essay in itself. It enters at every stage of the process and in every type of illusion. It has least effect when deception is carried on by external arrangements, by skillful counterfeits of logical inferences; its power is greatest where the subjective factor in deception is greatest, more particularly in such forms of deception as have been last described.

In this review of the types of deception, I have made no mention of such devices as the gaining of one's confidence for selfish ends, preying upon ignorance, upon fear, acting the friend while at heart the enemy, planned connivance and skillful plotting, together with the whole outfit of insincerity, villainy, and crime. It is not that these are without interest or are unrelated to the many types of deception described, but that they are too complicated and varied to be capable of rigid analysis: the moment deception becomes conscious, there must be acting and subterfuge to maintain the appearance of sincerity. If we add this great class of deceptions to those already enumerated, we may perhaps realize how vast is its domain, and what a long, what a sad chapter would be necessary to contain the history of human error.

Ethics is so closely related to psychology—right knowing to right doing—that a brief "*hæc fabula docet*" by way of summary may not be out of place. We find, first, a class of sense-deceptions which are due to the nature of sense-organs, and deceive only so long as their true nature remains unknown. These are neither pernicious nor difficult to correct. Next come a class of deceptions that deceive because we are ignorant of the possibilities of conjuring and pronounce upon the possibility or impossibility of a certain explanation in advance of complete knowledge; of this I have already said enough. But most dangerous and insidious are the deceptions in which self-deception plays the leading *rôle*. The only safeguard here is a preventive: the thorough infusion of sound habits of thought, a full recognition of the conditions under which the testimony of consciousness becomes doubtful, an appreciation of the true value of objective scientific evidence, and an inoculation against the evils of contagion by an independent, unprejudiced logical schooling. When once these evils of self-deception, fed by the fire of contagion and emotional excitement have spread, reason has little control. As Prof. Tyndall tells us, such "victims like to believe, and they do not like to be undeceived. Science is perfectly powerless in the presence of this frame of mind . . . . It [science] keeps down the weed of superstition, not by logic, but by slowly rendering the mental soil unfit for cultivation." With the spread of education, with the growth of the capacity to profit by the experiences of others, with the recognition of the technical requisites that alone qualify one for a judgment in such matters, with a knowledge of the possibilities of deception and of the psychological processes by which error is propagated, the soil upon which spiritualism and kindred delusions can flourish will be rendered unfit.

The French Academy of Sciences recently had a discussion about the "Canals" of Mars. A paper by M. Fizeau remarked upon the resemblance between some drawings of these objects and M. Nordenskiöld's view of the great Icelandic glacial crevasse in Greenland as indicating that the whole surface of Mars is covered, down to the equator, with a glacial ice-cap. M. Janssen thought that they were rather crackings resulting from the advanced planetary age of Mars, with excessive cooling and absorption of the oceans and atmosphere, or crevasses in the rocky crust corresponding with the furrows of the moon.

NEW LIGHT ON A LUNAR MYSTERY.

By GARRETT P. SERVISS.

EVERY possessor of a telescope knows that among the mountains of the moon there are some to which the name of "shining mountains" seems peculiarly applicable. The most celebrated of these is the huge extinct volcano Aristarchus, the slopes of whose crater possess such extraordinary reflective power that it is visible on the night-side of the moon by virtue of the comparatively faint light received from the earth. Another famous bright mountain on the moon is Proclus, which rears its crest high above the eastern shore of the so-called Crisian Sea. With a telescope I have seen Proclus glittering above the brownish plains surrounding it, in the middle of a summer afternoon, when, to the naked eye, the moon appeared as a faint silvery disk, half blended with the blue of the sky. There are other natural features of the moon's surface which shine with extraordinary brightness, the most conspicuous being the systems of long "rays," radiating from such crater-rings as Tycho and Copernicus.

But in addition to these long-known and easily recognized objects, there have occasionally been seen upon the moon certain bright points, which are even more curious and mysterious than the shining mountains. The earliest observation of this kind appears to have been made by Herschel in 1783. It was repeated by him in 1787, when he did not hesitate to report, in a communication to the Royal Society, that he had discovered three lunar volcanoes in a state of eruption. Astronomers have been considerably puzzled ever since to account for Herschel's statement. Nobody could question the accuracy of his observation, so far as the power of his telescope enabled him to carry it. At the same time, few, if any, especially in recent times, were willing to admit that that prince of telescopists had really seen volcanoes in action upon the moon. The complete absence of any evidence that volcanic activity did not cease upon our satellite ages upon ages ago militated too strongly against Herschel's assertion. The general conclusion finally was, that Herschel had been misled by the extraordinary brightness of some of the shining mountains which I have just described. It remained almost the only serious blot upon Herschel's record as an observer. He had described the appearance of the supposed eruption too carefully to admit any question as to his meaning. And yet, it seemed, a mere tyro in astronomical observation could hardly be deceived in such a manner, much less the most famous astronomer of his time.

But just now new light has been thrown upon the mystery, and it comes from that center of astronomical interest, the Lick Observatory. Prof. Holden believes that he has discovered, if not one of the same objects described by Herschel, a phenomenon of the same kind. It is hardly necessary to say that Prof. Holden has not discovered a lunar volcano in action, but the extraordinary appearance that he has seen sufficiently accounts for Herschel's mistake. It will be best to quote the Lick Observatory director's own words from his letter on the subject to "The Observatory," an English astronomical journal:

"I have never been able to understand how Herschel, the keenest of observers, could have been deceived in this observation until the night of July 15th of this year, when I was looking at the moon with the great telescope. At the southern extremity of the Alps, in the dark portion of the disk, not far from the terminator, I saw an illumination of the crest of a high peak which was extraordinarily and incredibly bright. . . . No part of this illumination seemed less bright than a first-magnitude star, and, taken altogether, it was the brightest object I have ever seen in the sky. It was apparently ten times as bright as neighboring portions of the moon's surface. Its yellow light was tinged in places with the purple due to the secondary spectrum of the objective; and, viewed as a whole, it presented the appearance of a vast conflagration—something quite foreign to the brilliant white of the rest of the moon's surface.

"It would have required no stretch of the imagination to have supposed it to be a tremendous eruption of a range of lunar volcanoes. . . . Observations on this and the succeeding nights showed that it was in fact due to a specially brilliant and favorable illumination of a mountain-ridge near the southern termination of the lunar Alps.

"I have now no doubt that the observation of Sir William Herschel referred to similar appearances."

Prof. Holden then refers to a similar, though less brilliant, display that was witnessed in 1843 by Dr. Gerling, of Marburg, apparently at the same spot on the moon.

I may add that there are at least two other recorded apparitions of this sort which were seen in that neighborhood, but evidently not in exactly the same place. The first was observed by Schroeter, the German selenographer, in 1788. He saw in the shadow of the great range of the lunar Alps, at the eastern foot of the mountains, a bright point, as brilliant as a fifth-magnitude star, which disappeared after he had watched it for fifteen minutes. Subsequently, when the region where this light appeared had become fully illuminated by the rising sun, Schroeter perceived, where the light had been, a round shadow on the surface of the moon, which was sometimes gray and sometimes black.

Nothing more was ever seen of the light, so far as any record informs us, until 1865, when Grover, an English observer, caught sight of it again, under circumstances similar to those of its first apparition, and watched it for half an hour, when it once more disappeared. It should be said that, in the case of Dr. Gerling's observation, referred to by Prof. Holden, a "small, round, isolated, conical mountain" was found in the place where the light had been, on the evening following its appearance. It is altogether probable that the gray or black spot perceived by Schroeter was the shadow of a similar mountain, for it is well known that some of the lunar mountains and hills are hardly visible at all except when lateral illumination indicates their position and form by means of the shadows.

Herschel thought he had seen three active volcanoes. If Prof. Holden's discovery accounts for one of these, it is possible that the observations I have just described may give a clew to the others. The phenomenon seen by Schroeter and Grover was located fifty or sixty miles north of the point where Prof. Holden beheld the extraordinary blaze of light last July, and at a point where the mountains, drawing around a culminating peak, confront with tremendous buttresses the broad level of the Mare Imbrium.

The objection has been made by Messrs. Elger and Williams, two competent English observers, that Herschel's volcanoes can not be identical with the glittering peaks seen by either Holden or Gerling, because the latter were observed close to the line of sunrise, where the morning rays touched them, while the phenomena that attracted Herschel's attention were situated far within that part of the disk where the only light came from the earth. But Prof. Holden does not say that the illumination he witnessed was identical in *place* with those recorded by Herschel, but simply that it was identical in *kind*. Besides, it must be remembered that, if these luminous appearances are due to peculiar angles of reflection, a similar effect must be produced whether the reflecting surfaces are presented to the sunlight or only to the earth-shine. The difference would be simply in the degree of brightness of the phenomena.

But while the discovery with the Lick telescope may account for Herschel's mistake, it does not clear up the mystery of the cause of these extraordinary lights. In every case quoted above, the illumination was evidently very much greater than that of Aristarchus, the most brilliant of the shining mountains. Proctor estimated that the reflective power of Aristarchus must be equal to that of new-fallen snow. But the mountain-crest observed by Prof. Holden blazed with a dazzling brilliancy that it would be difficult to account for except upon the theory that nearly all of the sunlight falling upon it was reflected to the observer's eye. Reflection at a particular angle from vast sheets of ice, as smooth as glass, might be suggested as the cause of such a display, but how could ice be there without water or atmosphere? The suggestion that has been offered to account for the brightness of Aristarchus and the "ray" systems, namely, that they are composed of metallic dikes and masses which, for various reasons, have escaped oxidation, is recalled by the phenomenon in question. Upon that view we might have to assume that these luminous points indicated the existence of tremendous crystallized masses, with polished surfaces, throwing back the glare of the sunshine like mirrors. But then we should not be far from the view set forth in Richard Adams Locke's celebrated "Moon Hoax," that some of the glittering eminences on the moon are nothing less than enormous quartz-crystals, whose dimensions are measured by miles instead of inches!

The fact that the apparitions of extraordinary luminosity are confined to comparatively very small areas, and are visible only for a short time and at long intervals, must be taken as an indication that the reflecting surfaces to which they are due must be of such a nature, and so disposed, that they can reflect the sun's light to us only when presented at a particular angle to our line of sight; just as a piece of looking-glass, exposed to the sun at a distance, suddenly darts a piercing ray when the eye comes within the plane of reflection. That these surfaces are the flanks of mountains is in the highest degree probable, and this but serves to heighten the impression of their extraordinary nature.

The rapid appearances and disappearances, and the long periods of invisibility, are readily accounted for by the various librations of the moon, whereby it presents its disk to us at a continually varying angle, as it swims along in its "squirming orbit," under the conflicting attractions of the sun and the earth.

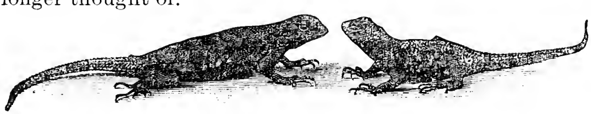
The place of drawing in the formative system of education is defined by Mr. W. Cave Thomas as that of the gymnastics of the sense of sight. It doubtless held a similar place among the Greeks, who, taking a lesson from the success of the formative training in their athletic games, perceived that the gymnastical system might be applied not only to the proportionate development of the body, but also to the joint development of all the faculties, and to that of the sense of sight, by the practice of drawing. Instead, however, of applying so good an example, our systems of education tend to destroy the true proportions of the faculties by cramming all sorts of knowledge into the brain. Educationists seem to forget that their object should be to promote the power of using knowledge rather than the accumulation of great stores of information. The acquisition of every new element of knowledge is equivalent to the expenditure of a certain amount of vital force, and every addition of new studies leads toward the verge of nervous power. The true object of education should be, while giving the student power to utilize any kind of knowledge, still to leave him with a working margin of vital energy.

THE PINE-TREE LIZARD.

By CHARLES C. ABBOTT, M. D.

ON the outskirts of the quaint little village of May's Landing, N. J., there is seen that rare object, an abandoned railroad. Starting near this place, and running eastward for a distance of some six miles, is a single track, laid upon a substantial road-bed of gravel, and extending through typical Jersey pine-barrens and cedar-swamps. For several years not a car has passed over the rails, which, left to nature, have grown nutty-brown with rust, and often concealed by luxuriant growths of false ipecac (*Euphorbia ipecacuanhæ*), great circular mats of deep purple or pale-green foliage, for such is the freak of the plant to vary thus in color.

When I visited this spot late in May, 1887, the charm of the abandoned railroad was rivaled by the beauties of the surroundings. The glistening snow-white sands were thickly starred with golden Hudsonia; the creek's banks, weighted with densest foliage, brilliant with sarracenia in the height of its glory, and everywhere the more modest grasses gave way to sparkling sun-dews. One knew not where to turn, so crowded were the spot's enticing features, and the rambler was likely to return empty-handed, as is so apt to be the case where attractions are spread out in bewildering profusion. Wondering what novelties might be in store as I passed the outlying traces of the village, I soon found my progress suddenly and effectually stayed—I had reached the tottering, crumbling trestle over Babcock's Creek. Here the gray lizards found a most congenial home, and the peculiar locality offered every reasonable facility for studying them. A long-desired opportunity was at last mine, and birds and botany were no longer thought of.



Pine-Tree Lizards (*Sceleporus undulatus*).

This pretty creature, known as the gray or pine-tree lizard (*Sceleporus undulatus*), is also, in many localities, called the "brown swift"; and this seems a most appropriate name, as we read the remarks of Holbrook, De Kay, and of Alexander Wilson, on the habits of the creature. For instance, the last named, in his "Ornithology," expresses surprise that a sharp-shinned hawk should have captured one, "as lightning itself seems scarce more fleet than this little reptile." I was not prepared, therefore, to find the "swifts" on the trestle anything but swift. It was by hiding, and not through speed, that they sought to escape, and it proved comparatively easy to capture them with the unaided hand. Often they played bo-peep merely around the timbers, and were readily surprised, so that they ran into one hand as they avoided the other. This proved to be the case, also, when I searched for the lizards in the pine-woods, which were as readily captured when up on trees as were those on the trestle.

The village boys adopted ordinarily the simple plan of using a thread-noose placed at the end of a short stick. Dropping the noose gently about the neck of the lizard, they lifted the creature slightly, when its struggles at once tightened the thread and made it a prisoner. It was a favorite pet with the children, and, when I asked some of them if it ever bit or snapped at their fingers, they were greatly amused. I lay stress upon this point, because of the rather widely spread opinion that these lizards are venomous. It is one with the equally absurd impression, due to ignorance and belittling prejudice, that all our snakes are harmful; but a curious feature in this case is the fact that the impression of the lizard being venomous obtains in inverse ratio to the abundance of the animal. Where exceedingly rare, the lizard is dreaded; while, where abundant, as at May's Landing, it is a favorite pet with the children.

Probably a closer study of animal life would materially reduce the list of species supposed to be harmful by those who see but little and know absolutely nothing about them, and put an effectual check upon those who, taking advantage of the ignorance of their audiences, assert deliberate falsehoods, because more entertaining than the simple truth.

As is well known, the pine-tree lizard is quite sensitive to low temperatures. It does not make its appearance in southern New Jersey earlier than May, nor remain abroad later than September. Of course, this is a general statement, and only approximately true, as all such statements must be. Perhaps there can be found nothing more absurd in scientific literature than the frequent *ex-cathedra* statements—for instance, concerning the movements and range of our birds, as though the latter recognized any other law than that of their own convenience and fancy.

At May's Landing I found the lizards sensitive even to the ordinary variations of temperature of average summer days, observing that, whenever it was cloudy, they were far less abundant, and actually sluggish. On the other hand, the extreme degree of heat to which they are willing to expose themselves is not a very high one, judging from the actions of a large number kept in confinement.

Fifteen adult lizards were placed in an inclosure in which every prominent feature of their homes was reproduced. I found that at 120° Fahr., with the atmosphere perfectly still, they invariably sought shelter, clustering in one cooler and dark corner; but at 100° they were exceedingly active, particularly if hungry, and made no effort to avoid the direct rays of the sun.

When exposed to a sudden transition from a very high to a low temperature, they quickly became inert, and, as the warmth was allowed to increase, it was instructive to see the sluggish movements of both the lizards and the imprisoned flies give way to more active ones, which culminated in the restored suppleness of the reptiles being equal to the capture of the swiftly darting insects. Forced exposure, for a period of three hours, to a temperature of 135°, caused death in four instances, and brought about a condition akin to æstivation in nine specimens thus exposed. As the pine-tree lizards are always found in localities where there is adequate shelter from excessively high temperature, it is not probable that æstivation ever occurs, as it does occasionally among some of our wild mice; but it is interesting to note that a condition closely allied to it can be artificially produced.

The conclusion reached by both field observation and experiments was, in brief, that when the temperature is such that those forms of insect life upon which they depend become inactive, the lizards withdraw to their shelters and likewise remain quiet if not asleep, this period of inactivity extending over several days, as during the prevalence of a northeast storm, or a protracted "spell" of cool and cloudy weather. Again, experiments with a large number in confinement showed that when kept without food at a low temperature, they lived for many days, while a like number starved in a short time when a high temperature was maintained. This lizard, therefore, appears to be one originally belonging to a tropical climate, that has gradually become adapted to a temperate and variable one.

The normal coloring of the pine-tree lizard is distinctly protective. Whether this has been gradually acquired or not, it is certain that it now renders the animal quite inconspicuous. Particularly when it is resting upon a rough-barked tree is this true; and one of my first objects, in studying the species in its native haunts, was to determine how far the markings were changeable and under their owner's control. Many specimens were found to be quite dark—indeed, almost black—while others were so light that the undulating transverse bars upon the back were very distinct and discernible at a considerable distance. This difference, I am quite sure, bore no relation to the surroundings; and the specimens subsequently collected and kept under daily observation for nine weeks practically retained the light or dark coloring they possessed at the time of capture. In confinement many individuals remained of a light color under all circumstances; others, that were dark when received, became light for brief periods, but were very dark fully ninety-five per cent of the time they were under observation.

The long and broad glistening green markings upon each side of the abdomen are equally variable, certainly not a distinction of sex, as suggested by Le Conte and Say, and often absent for weeks in specimens which occasionally exhibited them in all their brilliancy.

In no instance was there that prompt change of hue that we see in the tree-toad (*Hyla versicolor*), and even more so in the wood-frog (*Rana sylvatica*). The change in the latter is as abrupt and complete as in certain fishes, and is particularly significant, inasmuch as it is the only frog that needs protective coloring, living as it does in woodland tracts, where it is exposed to an abundance of enemies: and may it not be that, by its power to adapt itself to the general color of the surroundings, it renders itself inconspicuous to the insects upon which it preys? If so, the control over its color becomes doubly advantageous.

Vision in the pine-tree lizard is apparently not very acute, although the eyes are exceedingly bright, and, when coupled with certain movements of the head, suggest considerable intelligence. It was found very difficult to test their visual powers, although, once captured, these lizards became extremely tame, patient, and obedient, and I could only infer that the sense of sight was none of the best from the fact that when held to a mosquito-frame in a window, upon which house-flies were walking, they missed fully one half of those at which they snapped; and other lizards in confinement, but where every possible freedom of movement was practicable, often made many attempts to capture flies before success crowned their efforts. If, therefore, when at large, they depended principally upon winged insects for subsistence, their lives would indeed be laborious ones; but insects of sluggish movements, ants, and small spiders, are all freely partaken of. My friend Mr. George Pine, of Trenton, N. J., a very careful observer, assures me that of the two insects, house-flies and Croton-bugs, his lizards certainly preferred the latter, but were not particularly expert in capturing them. And now, assuming that the eye-sight of these little reptiles is not highly developed, what of the curious "pineal eye" which they possess? Prof. Macloskie has recently announced in "Science" that it "is so well developed . . . that it may probably seem to warn its owner of the advent of daylight. It is a lenticular, glassy area of the skin of the vertex (about a millimetre in sagittal diameter), surrounded by a yellow border, and having a dark spot in its center. The dark spot is opaque, caused by a mass of pigment internal to the dermis, set on the extremity of a pineal outgrowth from the brain. The clear area around it is caused by the dermis, which is transparent and free from the pigment which covers it internally in other parts. The eye is covered by an escutcheon-shaped epidermal shield, more transparent in the center and larger (three by three millimetres) than the normal epidermal scales. The only sign of degeneracy is the central cloudy mass of pigment, like a big cataract."

I was naturally desirous of determining for myself how far it was sensitive to light, but found the investigation beset with difficulties. Chloroformed lizards that were deprived of their eyes, although the amputation was dexterously performed, did not revive sufficiently to make their subsequent movements suggestive; or did sympathetic ophthalmia set in and affect the pineal eye?

I subsequently hit upon a plan, using very thin India-rubber cloth, by which the eyes proper were effectually closed, and the "eye" of the vertex left free. The lizards thus provided with a blinding head-gear were separated from their fellows and placed in a roomy inclosure, made up of several almost dark and very light alternate sections, the temperature being even throughout the lizards' range. The arrangement was, perhaps, too artificial for a satisfactory series of observations, but it became evident at once that the lizards recognized the difference between the dark and light areas, and their prompt return to the latter when removed from them, and again their actions when they returned, all showed the appreciation of a difference, which I know was not one of temperature, but beyond this I could determine nothing; but I recalled, at this juncture, the significant fact that in the woods about May's Landing I noticed many lizards buried in the fine sand and leaf-mold, their eyes closed and covered, but the top of the head and a portion of the back, for its whole length, exposed. The same was subsequently noted as a position frequently assumed by the lizards in my Wardian cases. If, therefore, the "pineal eye" is sensitive to light, it is still of some use to the creature, as it would certainly respond to a passing shadow, and so warn the animal of the approach of a possible enemy. It certainly would be greatly to the lizard's advantage if it had a perfect eye in the top of its head, especially when it rests upon the trunks of trees, and is exposed to the attacks of predatory birds; but the "pineal eye" is at most but a remote approach to this. On the other hand, it was found that whenever I converged the rays of light with a burning-glass, always so suddenly that no thermal effect was produced, there was caused a movement of uneasiness, a flinching, on the part of the lizard that was extremely suggestive.

The most superficial examination of the external ear of the pine-tree lizard will at once lead one to infer that the animal's hearing is acute; and this is true. When watching the lizards on the trestle over Babcock's Creek, at May's Landing, I was forcibly struck with this fact. Such of them as were basking on the timbers of the bridge were not disturbed when I approached them with moderate care, stepping only on the cross-ties, or between them; but if I struck the rails with my cane they instantly took notice of it and assumed a listening attitude. I subsequently experimented upon this point, and found that when my companion struck the rails a smart blow, even at a distance of fifty yards, the lizards were aware of the peculiar sound, and acted accordingly, even darting out of sight with that swiftness that characterizes their first few steps. I have recently learned from Rev. John E. Peters, Sc. D., of May's Landing, that his observations lead him to conclude that the sense of hearing is not very acute, and that they depend principally upon that of sight for safety and the finding of their food; but his experiments were not so extended as my own, and limited too largely to specimens in confinement.

It is a most interesting fact, although so very wild when first met with, that, once captured, they instantly become tame. Indeed, I have had them lie quietly upon my hand, while walking in the woods, and make no effort to escape. There is a bare possibility that the efforts on their part to escape, and fear, when finally captured, may produce a hypnotic condition, or something like it, but this would pass by and leave them wild. This, I think, never occurs. Once in my hand, I have never known a pine-tree lizard to be otherwise than perfectly tame. But, in a large series in confinement, I found that the sense of hearing was constantly brought into play, as shown by their ludicrous actions when flies, shut in a thin paper box, were placed near them. They not only heard but recognized the noise—a very important matter, bearing as it does upon their intelligence. Indeed, in the woods about May's Landing I found that the lizards were perfectly familiar with many sudden sounds and paid no attention whatever to them. Some of these were the sonorous croak of the bull-frog, the quick scream of the blue-jay, the rattle of the golden-winged woodpecker, and the coarse cry of the great-crested fly-catcher. These were all unheeded, while my own coughing, the whistling of a single note, or the loud utterance of a word, caused them either to assume a make-ready attitude or to dart away. On the other hand, have these lizards any voice? Their actions *inter se* are strongly suggestive of the affirmative, but, so far as I am able to determine, their utterances are confined to hissing, and this I only heard when I provoked the creatures by the sudden infliction of severe pain. Among a large number, in nine weeks I never heard a voluntary hiss. This, however, is wholly negative evidence, and I am disposed to believe that an animal possesses a voice, if its habits, in their entirety, suggest that it has one. This perhaps unscientific method of reasoning arises, on my part, from the fact of having long suspected that certain fishes and salamanders had voices, before they were detected—my suspicions being based upon the habits, as a whole, of these creatures. Certain snakes, too, that are now thought only to hiss, will, I believe, be found to have a limited range of scarcely audible utterances: so with the pine-tree lizards. I certainly have no reason to believe they talk, but possibly they may whisper in each other's ears.

Upon several occasions I sat, unseen by them, for a long time, very near my pen of lizards, and listened attentively, hoping to catch some sound that was clearly a voluntary utterance of a lizard. I only determined that one's ears, under such circumstances, become highly supersensitive, and a great deal is heard at a time when, in fact, positive silence prevails. Generally, the lizards were perfectly quiet, but at times one would move, and then a general scuffling ensued; but how far the noises were attributable to their activity I can not say; probably entirely so. The faint, snake-like hiss, that has fairly to be squeezed out of them, is the range of their vocal utterances, so far as I yet know.

Concerning the breeding habits of this creature, I had no positive knowledge prior to my visit to the pine-barren regions of southern New Jersey. I had heard the statement made that the eggs were small, quite numerous, and deposited on the under side of prostrate logs, and even in loose wood-piles that were constantly disturbed, and that the eggs were not concealed or protected in any way. All this I knew to be false; but where were the eggs of the pine-tree lizard placed? Questioning observing residents of localities where the species abounded, I was invariably informed that the eggs were laid in sand, in pits dug by the lizards and carefully covered up. They were only discovered by accident, no trace of their presence being noticeable. Further, that after heavy showers the eggs were sometimes exposed, and in this way a check was put upon the increase of the animal's numbers. Of course, solar heat alone was relied upon to mature the eggs. Recently, Rev. Dr. Peters has informed me that the eggs "are said to be laid in bunches," but just what is meant by being "bunched" I am at a loss to understand. They certainly are not attached to each other by any agglutinating substance. At least, the female lizards in my pens laid only dry, free eggs, which they deposited in conical pits, one egg, the lowermost, being in the bottom, then three above it, and four in the third tier. Such was the position in two sets of eggs, while the others were scattered over the sand in bewildering confusion. None of these hatched, the failure to do so, inasmuch as they were fertile, being due, I believe, to the surroundings being too dry. Probably a certain amount of decaying vegetable matter is mingled with the sand when the eggs are laid, and thus a moist heat is produced, which is as necessary as it is in the case of the eggs of the alligators and crocodiles.

The ova laid by my penned lizards were long, narrow, covered with a tough skin, free from calcareous matter, and varied in weight from twenty to twenty-four grains. At May's Landing, I am told, the eggs are usually laid about June 1st, and hatch about July 10th.

While the abandonment of their eggs in this apparently heartless manner leads to the supposition that they are indifferent to their offsprings' welfare, which is true, it is somewhat interesting to notice how very tolerant they are of the petty annoyances to which their own or another's young subject them. My observations on this point were made from a number of young and old confined in a roomy Wardian case, but probably what I there saw holds good among the lizards in their native haunts. I am sure it did among the many living on the old trestle at May's Landing. Often a little lizard, and sometimes two, would perch upon the head and back of an adult, and there be allowed to sit for fully an hour. The sharp claws of these youngsters seemed at times dangerously near the eyes and ears of the patient old one, but it offered no resistance, and, when I forced such burdened lizards to move, it was always with a deliberateness that suggested that they were really averse to disturbing those resting upon them. Again, adults would often rest upon each other, in what appeared to be a most uncomfortable manner for the one beneath, often pressing the head of the latter into the sand and completely blinding it for the time; yet I never saw the slightest evidence of ill-humor, not even when they were being fed. Often it happened that some sleepy fellow would quietly snap up the fly toward which another lizard was cautiously crawling, yet no fight ensued. Anything more trying than this to humanity can not be imagined, yet the lizards took every such occurrence as a matter of course.

In running, as well as when walking about deliberately, which they less often do, the lizard brings all four limbs equally into play, and their gait is much like that of a cat. When progress is suddenly arrested, they usually squat upon their hind-limbs only, holding their head well up and elevating the body, as does a cat or dog, by keeping the fore-limbs straight. Every attitude is suggestive of intelligence, and I refer particularly to the matter, because the differences in these respects between this lizard and the blue-tailed skink, the only other saurian found in New Jersey, is very marked; the latter, as we shall see, although having less suggestive manners, has, I believe, a greater degree of intelligence.

BLUE-TAILED SKINK (*Eumeces fasciatus*).

I have spoken of the rapid and complete submission of the pine-tree lizard when captured. While rowing from point to point along the rocky shores of Lake Hopatcong, Morris County, N. J., early in May, 1887, I chanced to see a beautiful "blue-tailed" skink, an old male that was now of a uniform rich brown color, and with a brilliantly red head. My one thought was to capture it—but how? I was in a profoundly cranky boat, and the water at this point was very deep. I tried a cold douche, and the bewildered skink, leaping into the lake, was caught as it clumsily swam toward shore. I placed it in a Wardian case, May 20th, and immediately it burrowed in the thick mat of sphagnum at the bottom, and for a week seldom if ever made its appearance. I could only determine that it was alive by searching for it, and invariably was bitten. It then showed a disposition to come from its inter-sphagnian retreat, but remained wholly suspicious of every sound or object that approached. Concealing myself, I watched it carefully, and found that the shutting of a door, the crowing of a cock near the window, and loud conversation in an adjoining room, always frightened it; while the singing of a canary, and of robins in a tree near by, were not noticed. A quickly passing shadow was particularly feared. Did it associate this with the birds of prey that are the skink's most dangerous enemies? Having disappeared, it never returned by the same burrow, but, cautiously peeping from a hole in an opposite corner of the case, studied the outlook for a long time before reappearing. It showed no disposition to be sociable until June 10th, when it seemed suddenly to gain confidence, but only to a slight degree. June 19th it ate for the first time, and then became somewhat tamer, but still was essentially wild, and seemed perhaps the more so because of the contrast with the pair of lizards that were all the while its companions. July 29th it was transferred to a roomy fernery belonging to a friend, where it found a close resemblance to its lakeside home in all essential features, and immediately it became more active; and now, nearly four months after capture, has become comparatively tame.

The skink, as we have seen, is exceedingly shy, irritable, and resents the slightest interference by biting savagely, but of course is entirely harmless. Nearly every prominent feature of the lizard is represented by an opposite trait in the skink. What appeared to be evidence of more sluggish wits than the lizard possesses, is the fact that it did not learn to associate my presence with a supply of food, as was true of the others, but the truth is it was its greater fear of man that held it back, and not really a want of cunning.

In many respects the skink recalls the snakes, and its manner of crawling, often without making any use of the posterior limbs, and generally keeping the body greatly bent, adds to the resemblance; and so, despite its shyness and courage when captured, evidences of intellectual strength, the skink seems lower in the scale of intelligence than the pine-tree lizard, but they are probably their superiors; and both are telling examples of the law of evolution.

THE LAST STAGES IN THE GENEALOGY OF MAN.

By M. PAUL TOPINARD.

II.—*Concluded.*

WE have still another question to examine before taking up the relation between the Old World monkeys and man. We have determined an intrinsic ascending series in the American monkeys. Can we find a like one in the monkeys of the Eastern Continent?

Two stages of evolution are first determined—one which concerns the tailed or ordinary monkeys, and the other comprising the four tailless catarrhinian or anthropoid apes, among which also two degrees are recognized—one for the gorilla, chimpanzee, and orang, and the other for the gibbon, which is the manifest transition between these and the tailed apes, more particularly the semnopithecoids. To these four must be added two fossil anthropoids—the *Pliopithecus antiquus,* observed in 1837 by E. Lartet in the Miocene of Sansan, an animal probably allied to the gibbon, and the *Dryopithecus Fontani,* which was found by Fontan in the Miocene of Saint-Gaudens, and which is incontestably an anthropoid, but something other than existing anthropoids.

We may also present as proof of evolution in the group of monkeys the *Mesopithecus pentelici,* of which M. Gaudry has collected in the Miocene of Pikermi, in Greece, specimens belonging to twenty-five individuals. It does not fit into any of the existing genera, but is allied by its skull to the semnopithecus, and by its limbs to the macacus. We can then suppose that it is the ancestor of these two by a kind of doubling of the type, such as seems to have taken place in a considerable number of marsupial types. M. Vogt involuntarily furnishes an argument in favor of this interior evolution. There is a gradation in the arboreal life of monkeys. The American monkeys and the semnopithecoids do not leave their trees; the magots frequently come to the ground, and are only half tree-dwellers; while the macacus and cynocephalus are ground-dwellers. It is not allowable for us to believe, in view of their perfect adaptation to life on trees, that the magots, and, with stronger reason, the macacuses and cynocephaluses, correspond to an effort in a new direction—a direction by continuing in which we could conceive that they might eventually raise themselves again to an intermittent oblique attitude, and thus favor new adaptations.

Gratiolet, at a time when he could hardly dream of the doctrine of evolution, from which, moreover, his religious sentiments removed him, conceived the idea of parallel series among the monkeys of our continent, leading, for example, from the semnopithecus, peculiar to Southern Asia and the neighboring islands, to the gibbon and the orang in the same region; from the macacus and magot to the chimpanzee; and from the cynocephalus to the gorilla. Without suspecting it, Gratiolet was preparing for the doctrine of the derivation of man from the monkey, and was associating himself with the polygenist ideas then in favor in the anti-orthodox school.

This leads us to our last genealogical stage—the passage from the monkey to man. I begin by describing the principal opinions on the subject that have been in vogue or that may be sustained. In the theory of M. Haeckel, who is monogenist for man as he is monophyllitic for the other branches of his genealogical tree, the tailless monkeys of the Old Continent constitute the nineteenth stage from the monera. They are divided into four branches, the fourth of which is that of the anthropoids; and this is separated into African and Asiatic branches, the latter of which is divided in turn into three; the third of which gives the Pithecanthropus, or man-ape, which has already a vertical position, but is without speech. It is his twenty-first stage, the anthropopithecus of M. de Mortillet, from which living man, the twenty-second and last stage of M. Haeckel, is derived by two branches—one for the woolly-haired negroes, and the other for the straight-haired races, of which the Australian was the prototype. The place where man was thus originated by the acquisition of articulate language is fixed on M. Haeckel's map to the southwest of India, where the hypothetical lemurian continent may have been. The spot is marked Paradise, and is the point of departure whence men have scattered in every direction—some west to Africa, others east to Australasia and Melanesia, others north to Europe and Asia, and thence by Bering Strait to America.

Mr. Huxley does not express his opinion on the immediate descent of man in any of his writings that I have read. He leaves the reader to infer the consequences of the discussions into which he enters, and these lead to an origin at the expense of the anthropoids.

Prof. Gaudry is also very reserved, but lets his opinion appear, while he does not give it distinct form. In his scheme the series rises, marsupials, ungulates, lemurs, and catarrhinians forming a single group; anthropoids; and man. The anthropoid designated by him is the dryopithecus, of which he says: "The dryopithecus was a monkey of a very high character, and approached man in many particulars; it was of nearly the same size; in its dentition may be recognized characteristics of the teeth of the Australian" ("Fossiles primaires," p. 236). Further on he adds: "If, then, it should be shown that the flints of the Beauce chalk collected at Thenay by the Abbé Bourgeois have been cut, the most natural suggestion to my mind would be that they were cut by the dryopithecus" (page 241); "unfortunately, we possess of this dryopithecus only a lower jaw and a humerus."

Prof. Cope has an opinion, peculiar to him, that man is not descended from the monkeys, anthropoid or other, but directly from the lemurs. His condylarthra, the stock of nearly all the mammalian orders, give rise especially to a branch which is divided into three, one being represented chiefly by the genus *Anaptomorphus*, and separating in turn into two branches, one of which engenders the monkeys and anthropoids, and the other leads directly to man. His principal reasons for this view, which follow, show on how little our genealogies sometimes rest. Man has, as a general rule, four tubercles or cuspids in his upper molars. The monkeys and anthropoids have usually five tubercles. The recent lemurs, the fossil Necrolemur, and the Anaptomorphus, have generally three tubercles. Now we sometimes observe three tubercles in man. Prof. Cope has drawn up a long list of the degrees of frequency of this form among the races. The reversion is one that works toward the lemurs, and not toward the monkeys and anthropoids.

M. Vogt's present opinion is radically different; but the learned professor at Geneva having at different times had nearly opposite opinions, and having played a considerable part in the question, we shall dwell longer with him. His first view was expressed in 1862–'64, before Darwin had formally applied to man his doctrine of derivation by selection, and before M. Haeckel had in 1867–'68 for the first time fully explained his genealogical tree. His second opinion is known to me through his magnificent book on the mammalia, which appeared in France in 1883.

In his first view, the author having exhibited the resemblances between the anthropomorphous apes and man, and defined the point from which the descent probably began, adds that it does not result that this descent follows a single way. There are secondary types among the human races, as there are among the monkeys. By prolonging the parallel series of Gratiolet we get the multiple stocks of man. "All the facts together, instead of indicating to us a common stock, a single intermediate form between the monkey and man, point to numerous parallel series which, more or less circumscribed, must have developed themselves from as many parallel series of apes" (p. 626).

The second opinion appears less clearly defined than the first. On the one side M. Vogt maintains his former ideas of polygenistic simian descent, and on the other he reverses them by formally denying that man is descended from the monkey. The monkeys, he assumes, have always, as they were in the Miocene and Pliocene epochs, been cantoned in tropical climates. Essentially tree-dwellers, they leap from branch to branch, and are hardly ever displaced—not even those ground-living monkeys that climb among the rocks. The separation between the monkeys of the Old and of the New Continents has always been complete, there having been no communication between the two hemispheres since the Eocene, or at least since the Miocene. Monkeys not going into cold countries, they were effectually prevented from approaching Bering Strait. They have, then, been but little modified, especially in the Old Continent, where they are more exclusively tree-dwelling. Higher types, like the laopithecus of America and the dryopithecus of Europe, are met among them after the Miocene, but they have undergone no further evolution since. The fact of M. Gaudry's mesopithecus is the only one that can be cited as in favor of any evolution.

But M. Vogt speaks here of a tendency toward a superior organization like that of man, of an approach by different ways, the gorilla resembling man more in its limbs, the orang in its brain, and the chimpanzee in its skull and teeth. "No fact," he says, "permits us to assume a single only line of evolution toward the human organization." Passing, then, more particularly to fossil species, M. Vogt insists upon his proposition that "there has been no evolution of the simian type through the geological ages," and that "we can not point to any advance of this type since the Upper Miocene."

I see nothing leading to this conclusion. As I have just shown, there are as many probabilities of an evolution among the apes as in any other zoölogical group. No series of species, it is true, leads positively from any ape to any man. But, in paleontology, what are exhibited to us as series of species are usually only series of characteristics. Comparative anthropology shows us a great number of characteristics forming series, proceeding from the apes to man, and passing or not passing by the anthropoids. M. Vogt ends with an argument that has more weight: "The infantile ape is more like man than the adult ape, and their differences, characterized by the evolution of the jaws, the cranial crests, etc., become pronounced only with age"; and, finally, "the conclusion results from all these facts, that man can be placed in direct generic relation neither with recent apes nor with any of the known fossil apes, but that the two (man and the ape) have risen from a common stock, the characteristics of which are still visible in the age of youth, which is nearer to the stock than the adult being."

M. Vogt's last argument is *a priori* correct. Every one has remarked the contrast between the skulls of the young and the adult orang or gorilla. Its value rests on the admitted principle of the parallelism of ontogeny and phylogeny, which is expressed by saying that the forms of the young subject reproduce forms that have existed in ancestors, and thereby indicate their filiation. In other words, the new characteristic in progress, that which should connect a species with a succeeding species, exists in the adult in the highest degree, while the characteristic that belongs to the ancestors exists in the infant when it is wanting in the adult. As an example, we cite the pulmonary respiration of the adult salamander and the branchial respiration of the young salamander.

But it is necessary to distinguish what is produced after birth and is a fact of the growth of the body, of physiological development by the progress of age in the individual life, from what is an ancestral resemblance dependent on the embryological and intra-uterine ontogeny. In the infant man, as in the young ape, the skull is rounded in every direction, uniform, and almost without asperities. The temporal crests and the sagittal crest, which is only the result of the elevation and lying back of the former on the median line, are developed on either hand with age, especially in the male, and are in relation with the strength of the muscles that are inserted upon them. They become considerable in the apes, and form large temporal bones in the species that have a considerable masticatory apparatus.

The superciliary arches grow in man and in the apes with age, and do not take so remarkable an aspect in the latter, in the anthropoids, for example, only because they have more ample frontal sinuses, which is a secondary characteristic. The projection of the jaws, also, becomes marked in both only with age; the human infant has an orthognathous, minute face, hidden under a skull forming a great ball, as in the orang; this face grows, lengthens, and becomes prognathous, partly by simple augmentation of volume while the skull becomes relatively diminished, partly because the molars of the second dentition need room and push the jaw forward.

I expect to describe hereafter how the relations between the base of the skull and the base of the face along the naso-basilar plane change, on either side, with the adult as compared with the infant, the angles which craniometry marks in that part. The facial angle, which I mention because it has a certain popularity, is larger in the young ape than in the infant man. The infantile forms of the young ape which M. Vogt speaks of are partly found in the adult woman. They also characterize the male sex of certain races, like the Andamans, which have for that reason been designated as infantine.

There is one characteristic implied in Prof. Vogt's argument which seems to bear more favorably to his thesis. It is that the young ape, the orang or chimpanzee, for example, is more intelligent than the adult. This, we might say, is because it is descended from a more intelligent ancestor than recent apes. But greater intelligence is a rule with all young animals, as well, if we take the circumstances into account, as with man. The brain is at that period larger in proportion to the body; it is in some sense virgin, more impressionable; it grows excessively, and asks only to absorb, to work, to turn the blood it receives to account. What is more marvelous than the way our children learn to talk, read, and write? Would we adults be capable of the amount of rapid memorizing which the mass of words and ideas inculcated into them at that age exacts? Young Australians are equal to Europeans in the schools, and retain languages with extraordinary facility; but, as age comes on, their savage nature reappears, they take off their clothes, they join their like again, and they manifest no more intelligence than if they had never been among the whites. If at our age we appear so capacious, intellectually speaking, it is because we have been accumulating for many years, because we reason in great part by habit, automatically; because we are incessantly excited by the struggle for existence, by the society of our likes, and by the use of language, which apes do not possess. M. Vogt's last argument, that the young ape is more human than the adult ape, does not, therefore, convince me.

I have mentioned the different opinions in view, positive and negative, concerning the origin of man. Are there not other possible ones? Although I have made many objections to M. Vogt's theory, his uncertainty, so remarkable on the part of a man who is usually not afraid to speak out, has made me reflect. I have asked what could this stock be which he speaks of, common to the ape and to man, and which is not lemuroid? While he leaves his readers still in suspense, it is easy to see his tendency. This stock started from some point in the ungulates. I have manifested my repugnance to supposing such an origin, which appears monstrous. But while this repugnance is legitimate when we have regard to recent species—the extremities evolved from the branch—it is less so when we go back to the trunk before the specialization of the ungulates had become as pronounced as it is now. It must be said that nothing is impossible in nature; that things the least probable when we look at the outcome are realized by the most unforeseen processes, the most tortuous roads. What selection by the hand of man has done for pigeons is found done in nature by means the laws and mechanism of which are invisible to us, and which we can only denominate chance.

There is one objection to the descent of man from the ape which I have entertained, and which comes to the support of M. Vogt's thesis. As I have previously said, the primordial type of the mammalia has four limbs, the destination of which is already written out as far back as we can go; all four fitted to walking, but the fore-limbs adapted besides to serve as organs of prehension, while the hinder ones are essentially organs of support and walking. This double specialization goes back to the reptiles, not to speak of the dinosaurians, with which it is very marked. Some amphibians present traces of it. With the most ancient mammalia which are known in all their parts, like the *Phenacodus primævus* of the Lower Eocene of Wyoming Territory, the fore-limb is well characterized as an organ of prehension and the hinder one as for walking. The humerus is articulated with a narrow glenoid cavity at the upper outer angle of the omoplate, so as to permit the freest motions in different directions; the radius is mobile on the cubitus, around which it performs the turning movement required by the function of the hand; the five fingers are spread out, the thumb is turned more on its axis as if to permit opposition, and the hand continues in a straight line with the forearm. On the other hand, the femur is united, as with us, to a massive pelvis; the articular surfaces of the knee, the knee-pan, and the two immovable bones of the leg, are just what the exclusive function of locomotion requires; the foot is plantigrade, with a prominent heel and close toes, and is articulated perpendicularly by its arch with the leg, as in man. With another contemporary animal of the same bed, the *Coryphodon*, of which I have only representations of the foot and hand, but those whole, to judge by, these two organs present more resemblance, the foot being a little like a hand, but the differentiation is nevertheless made.

This specialization or differentiation has reached its maximum in man, no other animal showing it in equal degree. In the bird the upper limb has become a wing, that is, a function of locomotion. With man alone the upper limb is exclusively a hand. The hinder limb condenses in itself all the locomotive function which it has till now shared within certain limits with the fore-limb, but which has nevertheless remained directly its essential attribute. Man thus seems to be the direct continuation of the first Eocene mammalia; if not of the marsupials that preceded them, the confirmation of a type that had been begun; and it does not appear very logical that his transformation should have been effected at the expense of a branch which appears collateral. The monkeys have been produced by an adaptation of the hinder limb to an arboreal life, the fore-limb remaining what it was; this is a deviation in some way from the axis of evolution, a deviation from the primitive type. From this primitive type have been detached on one side the ungulates through a metamorphosis of a fore-limb adapted to prehension into a limb adapted to running, and through a harmonic perfecting of the four limbs for the same purpose; on another side, the carnivores, whose four limbs have been set, together with the teeth, the jaw, and all the skull, into harmony with the necessities to which they were subjected and the mode of life and regimen they had adopted; and, on the third side, the monkeys, which, seeing the earth taken possession of by swift-footed herbivores and bloodthirsty carnivores, have taken refuge in the trees, or at least have flourished and maintained themselves there, and have consequently fitted their extremities to that special kind of life.

For men to be derived from monkeys through the disappearance of the accidental adaptation of the hind-limb to a function normally devolving on the fore-limb—that is, by returning toward their primitive arch-ancestral type—seems strange. But it is possible, for nature does not take the shortest roads. From the carnivores, terrestrial animals, have descended the pinnipeds, which by a reversionary adaptation have had their limbs atrophied, brought near the body in the shape of paddles, and made to perform the part of fins. But the most probable is generally the most simple. The hook which such an evolution of man or of one of his precursors would have made is useless. It seems more rational to conceive the perfect bipedal and two-handed type as descending from a type which we have already seen marked out in Eocene times, and constituting the fundamental original of the mammalia. We should then have to consider the simian branch as a collateral branch in which the evolution has not gone beyond what is exhibited in the recent and fossil anthropoids.

This hypothesis would solve some difficulties in anthropology that seem insurmountable. The lowest human races known to us are so near to the higher races in proportion to the distance that separates them from the monkeys, that we can consider the different men as forming a relative homogen—a species, as M. de Quatrefages contends. The most ancient human race, that of Neanderthal, is in the same category. Its cranial capacity—that is, that which really characterizes man—is still considerable and higher than in the lowest existing human races. Between the lowest mean of the capacity of the skull of human races, which I put in round numbers at eleven hundred cubic centimetres, and the mean of the highest anthropoid species, which I estimate at five hundred and thirty cubic centimetres, the distance is prodigious when we compare it with such slight mean differences—taking account of the relation of brain-volume to that of the body—as have been determined between the succeeding species, genera, families, and orders of animals. The working of such a cerebral transformation as this calls for would require a length of time defying all our conceptions.

Pliocene man has probably been found in America. Miocene man is indisputable, although we have not yet been able to demonstrate the fact. Now, it is in the Miocene that the monkeys appear with their existing characteristics. Has man, then, been constituted since they appeared? Did the evolution choose an animal whose hind-limb was organized for a life in trees, was at once hand and foot, when there were beside it and already previously existing animals whose organization presented a part of the desired characteristics? There is little probability of it; and considering, I repeat, the number of species which would have been needed to reach the actual constitution of our brain, it seems probable that the preparatory steps are rather taken in the Eocene epoch at the expense of one of those condylarthra which had already the principal morphological characteristics of man except those relating to the brain, and which Mr. Cope has shown to be intermediate between the marsupials and most of the recent mammals. From this point could be made the differentiation corresponding with different modes of life, which has given on one side the ungulate and carnivorous branches and many others that disappeared without forming a stock, and on the other side the quadrumanous and human branches.

The human type—that is, the type that was destined to result in the astonishing brain-development that we know, and to which all the rest is only accessory—had then a stem of its own—a stem which was the most central continuation of the general primitive trunk of the mammalia. In the present order of science, the mammalian class, as a whole, is compared to a branching tree, having numerous principal limbs, each terminating in efflorescences higher in growth. These are our most specialized groups, the *Equidæ* and the ruminants among the ungulates, the lion and the dog among the carnivores, etc. In this new system the comparison to an upward-growing tree, the central axis of which put out lateral branches, would be more just, the central stalk of it continuing to rise like the Lombardy poplar, and giving at its apex man.

Gentlemen, we have reached the end of our year's task. I have explained at length the genealogy taught by M. Haeckel, and have examined step by step the systems that have been proposed to take its place. We have inquired whether the point of departure of the vertebrates has been from a soft-bodied worm, or from a crustacean possessing an exterior skeleton. We have concluded that our genealogy has passed by the ganoid fishes, to land in what paleontologists call the labyrinthodonts, and what I have sometimes designated as medium vertebrates. Thence the current has carried us, not in the direction of the mammals, which, however, had already appeared in the Triassic age, but into the full dominion of the reptiles, where we speculated concerning the dinosauric origin of the monotremata or of some similar group. There we met the aplacental marsupials, which we designated as confirmed pro-mammals, and showed that, with some reserves—of the cetaceans, for example—all the recent placental mammals, and consequently ourselves, have issued from them. Here the problem became complicated. To this point, except for the origin itself of the mammals, our origin appeared clear. The lemurs were already a cause of embarrassment. The uncertainties increase respecting the immediate descent of man, although we have at last freed ourselves from prejudices respecting it, and can discuss it coolly. Several opinions, each advanced by illustrious authorities, confront us; I have expounded them impartially, occasionally myself raising objections, as well as favorable arguments. I have not done, and now you may say that I have some secret preference—that you are convinced of it.

There are for me only two doctrines to be considered—one which derives man from the primary stock of the mammals in a direct line and without the intervention of orders, not from a mathematical point, but from that confused mass succeeding the marsupials, in which the differentiations are indecisive and tend toward the ungulates or toward man; and the other one, which accepts the branch or the order of the primates with all its consequences—the lemurs or prosimians at the base, then the monkeys or simians, and man all alone at the summit.

Does one of these ennoble us more than the other? Certainly. The one that regards us as the dominant and central branch of the mammalian tree, the continuation of the prototype in the direct line, and which posits us as the crown of an evolution, the point of departure of which is at the monera, is well calculated to flatter our pride. But is it true, and would not our choice of it be a subjective one?

All that I have told you this year and last shows that I incline toward the other solution, and the conclusion that we are descended from the monkey. One consideration to me takes the lead of all the others. The type of the cerebral convolutions in all the primates where it is well characterized in its ascendant evolution is that of man; it varies from the cebian to the pithecoid, from that to the anthropoid, and from the last to man only in degree.* The development to the extreme of the simian type of the circumvolutions, and the abrupt increase in the volume of the brain in passing from the anthropoid to man, on which I have insisted, are, apart from the histological examination, the two fundamental anatomical characteristics of man.†

That the foot of the monkey has a more or less opposable thumb; that it is more or less adapted to their arboreal life; that it should appear strange to us that the human line, after having experienced a partial transformation of its foot, should have resumed the original foot of its ancestors—these are details. The cranial and facial characteristics, which are the result in man of the considerable volume of his brain, the atrophy of the nasal fosses, and of their numerous posterior cavities, which has brought about the disappearance of the muzzle, the compensatory perfection of the touch and the vision, which, with the modifications necessitated by the equilibrium of the skull, have contributed to a bipedal attitude and an entire new series of differential characteristics—are details also. That which dominates all is the cerebral type, already human, but in a rudimentary condition, in the apes, as it is the same type amplified and perfected in man.

All the organs—foot, hand, teeth, thorax, pelvis, and digestive tube—have been evolved in the mammals, have been transformed capriciously, have taken different courses, and have been specialized in different directions, sometimes to the same result. One only has remained stationary, or has varied but little—the brain—except in man. With him, or one of his ancestors among the primates, it took a start, it grew, developed, making everything bend to its needs, subordinating everything to its own life

* See P. Broca, "Anatomie comparée des circonvolutions cérébrales," "Revue d'Anthropologie," 1878, p. 385.

† According to M. Chudzinski, a competent authority on the subject, not only the type of the circumvolutions, but the muscular and visceral anomalies found in man, plead in an equal degree in favor of a simian descent. Some of the muscular anomalies even indicate reversion toward climbing or tree-living dispositions. See the memoirs of this anatomist in the "Revue d'Anthropologie," on "Muscular and Visceral Variations in Races," and in the bulletins of the *Société d'Anthropologie* on "An Anomaly observed in the Orang." See also his great work on the "Comparative Anatomy of the Circumvolutions," which was published in 1878, and reviewed in the "Revue d'Anthropologie," 1879, p. 707.

—the skull, the face, the whole body—and leaving its mark everywhere. Fishes swim, ruminants browse, carnivorous animals hunt their prey, the monkey lives in trees, man thinks. All in him gravitates around this characteristic. The philosopher has rightly said, "Man is an intelligence served by organs."

We are, then, descended from monkeys, or at least everything looks as if we were descended from them. But from what monkey, known or unknown? I do not know; assuredly none of the recent anthropoids has been our ancestor. From many monkeys or only one? I am ignorant of that also, and do not know whether I am a monogenist or a polygenist. In the study of the human races, I perceive arguments for and against both systems. I hope to reach their examination in a future course. Till then I ask for a reservation of opinion.

The subject we have been discussing is not done with; in fact, what I have said of my own opinion is premature. My earlier lectures next winter will bear on the comparative morphology of the skull, from the fish to man, especially among the mammals. Now that our descent from monkeys is contested by persons who are themselves partisans of our natural descent from the animals, it is of importance that we do not concentrate our exclusive attention on the primates. We shall see what arguments comparative craniology brings in favor of this or that genealogy or against it. We shall thus come upon atavistic traits which we shall then be in a situation to comprehend, upon rudimentary organs, upon analogies, and finally upon characteristics of the evolutionary order, or zoölogical ones, which I have divided in my programme into two categories—the retrogressive and the progressive characteristics. We shall thus complete the study of the cranial characteristics dependent on the brain, with which I began, and shall be able to pass to the characteristics derived from the skeleton, among which we shall again find the application of all the preceding evolutionary data. Then only shall we be permitted to conclude upon the place which anthropology makes for man in nature. Whatever may be the result we reach, this place, you may believe, will be as enviable as you could desire it to be.

I have said, in anticipation, that man is descended from the monkey; yes, but by a multitude of intermediaries more or less anthropopithecoid, of which paleontology possesses no remains as yet, but which the mind foresees, the first one having a brain like that of Vogt's microcephalus, its followers larger brains, with more circumvolutions, larger frontal lobes, down to the existing type. Originally, at about the beginning of the Miocene, perhaps, man and monkey made but one. A separation was produced, the gap enlarged, became a crevasse, then a gulf with steeper and steeper walls like the Colorado cañons—a gulf which our friend

Abel Hovelacque is not in favor of, but which MM. Vogt and Huxley, who are little suspected of orthodoxy, admit—a gulf which is growing wider every day under our very eyes; in which we are still permitted to perceive those lost paths, going from one side to the other, of which Mr. Huxley speaks in the preface to the French translation of his "Man's Place in Nature"; but which will soon become insuperable by the disappearance, on the one side, of the last existing anthropoids, and, on the other side, of the last inferior human races; when man will be left isolated and majestic, proudly proclaiming himself the king of creation.

We need not blush, then, for our ancestors: we were monkeys, as before them we were reptiles, fishes, yes, even worms or crustaceans. But that was a long time ago, and we have grown up. Evolution, let us say it, has lavished its favors upon us, and has given us all the advantages in the struggle for existence. Our rivals of yesterday are at our mercy; we leave those which displease us to perish, we create new species when we want them. On our planet we reign, fashioning things at our will, piercing isthmuses, going down into seas, ransacking the air, suppressing distances, and snatching from the earth its secrets of ages. Our aspirations, our thought, our action, have no bounds. Everything pivots around us. What more can we desire ? To be god ? That may come. Evolution has not had its last word. The anthropopithecus has been; the anthropotheomorphus may be. M. Hovelacque has tried to reconstitute the one; why may we not some day try to constitute the other, the man of the future ?

ATOMIC WORLDS AND THEIR MOTIONS.

By Dr. HEINRICH HENSOLDT.

THIS formidable title will doubtless lead many of my readers to apprehend that I am now going to inflict upon them one of those abstruse and profound disquisitions on molecular physics which are very learned and very incomprehensible. But I do not propose to do anything of the kind. I have no desire to go into mathematics, or to weary them with a more or less tedious recapitulation of the gradual development, from crude beginnings, of our present science of molecular dynamics, by going back to the earliest conceptions of atoms by the Greek philosophers, or even to the time of Dalton and Bernouilli.

I merely desire to explain, in as popular a language as the subject permits, in how far the researches of men like Helmholtz and Sir William Thomson have modified our ideas of the ultimate composition of matter. There will be nothing offered that is absolutely original except certain deductions of my own which, in my opinion, necessarily flow from the assumption that matter is composed of indivisible and indestructible particles. I have reason to believe that these deductions will be received with interest and that they will throw light on and explain many things which may have puzzled those not intimately acquainted with the subject.

It may, indeed, be presumed that a popular exposition of the present state of the science of molecular physics will be appreciated. Everybody has heard of and knows something about the atomic hypothesis, yet there are few who have been able to follow the more recent researches and speculations of the foremost inquirers in this difficult department, because they have been communicated to the world in a manner in which they can only be understood by mathematicians of the highest order. Such master-minds are necessary, and it was perhaps fortunate for mankind that they have hitherto confined themselves more or less exclusively to original research, and not frittered away their time by writing popular works; but it is the duty of humbler intellects to interpret their revelations, and give them the widest possible dissemination.

There is, in my opinion, no subject, outside of mathematics, however intricate or abstruse in some of its aspects, which can not be explained in the ordinary language of the people. What can be clearly imagined can also be clearly expressed; or we might as well carry science and philosophy back to the time of Duns Scotus, when it was considered the greatest triumph of learning to sophisticate so profoundly, and hedge around with arguments an obvious absurdity that no ordinary intellect could refute it.

I would also like to observe that in the manner in which I shall here endeavor to place this subject before my readers I have been largely influenced by the perusal of a recent work on molecular dynamics by Lasswitz, a German physicist and philosopher, little known as yet in this country, a profound thinker. To this work, which can not fail to make a great impression on all cultured minds, I am indebted for many of the similes which I intend to make use of. Some of these similes may appear fanciful or extravagant, but a little reflection will show their fitness and value in the interpretation of some of the more difficult problems with which we are here confronted.

Let us imagine ourselves, on a cold and clear winter night, suddenly transferred from this greatest and noisiest of American cities, hundreds of miles away, into the stillness of the country, or into the depth of some solitary forest.

Nothing around us seems to stir; we are far from the roar of cities; above us the silence of the stars, beneath us a soft carpet of snow; not a sound to be heard, not a breath of wind stirring the branches.

And yet we know that all this is an illusion! Those bright points of light on the dark firmament are solar systems, whirling through space two hundred times faster than a cannon-ball, and under our feet the delicate snow-crystals are groups of atoms, which tremble with billions of vibrations every second.

The outer forms of the little snow-stars appear to us fixed and rigid like those of the bright constellations above. But from their surfaces a pale light enters our eyes, acts on the retina, and excites the optic nerve—an infallible proof that there is something active even in these—and we know of only one kind of activity in this universe, namely, that of motion.

The particles of which the snow-crystals are composed are not closely joined or cemented to each other like the stones in a wall. They are perpetually acting and reacting on the bodies which surround them, through the medium of an exceedingly fine substance which we term world-ether. It is the bearer of the movements, the effects or modifications of which we know as light, heat, electricity, chemical affinity, etc.; it also keeps the particles of the snow-crystals separate, maintains them in a state of mutual equilibrium, and regulates their vibrations. These vibrations we term the "mechanical cause of heat," because we are aware that every increase of temperature is represented by an increase in the rapidity of the vibrations.

These minute particles, of which, as we know, all bodies consist, are called molecules. In solids, as, for instance, the snow-crystals, they are arranged in a certain fixed order, and their vibration is limited to a given space. Now, let the sun shine on the snow.

The sun is a vast center of activity. From every point of its surface an enormous number of impulses are continually acting on the atoms of the surrounding ether, which are sent through space in every direction, with lightning-like rapidity. The number of these impulses has been estimated at from four to eight hundred billions per second. They give rise to a wave-like motion which traverses about two hundred thousand miles of space per second, and requires eight minutes to reach our earth.

If these ether-waves happen to come into contact with our optic nerve, we experience the sensation of light; if they impinge upon our skin, we feel warmth; if they strike the snow, they set its molecules, as well as the ether between them, into a livelier state of motion. The vibration of the molecules increases in violence, and the result is an increase in temperature in the snow. The particles have to move further away from each other, as their vibrations require more space—we say the heat expands the bodies. At length the vibrations become so energetic that the fixed order in which the particles are arranged can no longer be maintained. They begin to collide and interfere with each other; the whole artificial edifice of the crystal collapses. The molecules can not regain their equilibrium—the snow has changed into water.

In liquids the molecules move about in all directions, yet none of them can voluntarily separate itself from the main body. Just as in a vessel, completely filled with live eels, each individual fish may wriggle and move about among the others, yet it can not detach itself or swim away from them. The liquid particles are not yet sufficiently potent or energetic to overcome the pressure exerted upon them by their surroundings. Above the water, even in the open vessel, they have to encounter the pressure of the atmosphere, the molecules of which keep up a constant and vigorous bombardment against the liquid particles, forcing them down. Still, this can not prevent that here and there a favorably situated water-molecule pushes itself between the air-molecules; the water evaporates. Now, if the temperature is heightened—that is, if the vibrations of the water-molecules increase to such an extent that they can hold their own against the pressure of the air—then a condition of things is brought about familiar to us under the name of *boiling*. The water-particles shoot about very rapidly; they are no longer crowded together, they force their way through the air-molecules and disperse—the water *evaporates;* we have no longer liquid but gaseous water.

In gases—as, for instance, the air, carbonic acid, etc.—the molecules are in a state of vibration so violent that they fly about with marvelous rapidity in all directions.

Now, we are in possession of information—of pretty accurate information—respecting these molecule-movements. The researches of men like the late Prof. Kingdon Clifford, Prof. Helmholtz, and, above all, Sir William Thomson—one of the ablest physicists and beyond comparison the greatest living mathematician as well as one of the subtlest thinkers the world has ever produced—the researches of men like these have thrown quite a flood of light on this important and highly interesting subject. Nor is our information merely confined to molecular movements and vibrations; the dimensions of the molecules themselves have been approximately ascertained, because, from known facts of pressure, friction, and heat-conducting capacity, very reliable conclusions can and have been drawn.

The air which surrounds us is a chaos of innumerable minute solid bodies, flying rapidly about in all directions. Our skin is perpetually bombarded by them, and it is this bombardment which causes us to experience atmospheric resistance or pressure. These air-molecules, if closely packed (without any intervening space), would only fill about $\frac{1}{3000}$ of the space taken up by the air as it is. They rush about in this void with the quickness of rifle-bullets. Every point of our skin is struck by at least five thousand millions of these little bullets every second. Their number is so great that every cubic inch of air contains no less than twenty-one *trillions* of them, and the same is true of all gases. They are so small that they are utterly beyond our powers of perception.

The smallest object which the best and most powerful combination of lenses, as now produced, would still enable us to recognize, requires a diameter of at least $\frac{1}{4000000}$ of an inch, but of oxygen-molecules three hundred could be placed side by side before they would cover that minute distance. Still smaller are the molecules of hydrogen.

Now, in order to get a clear idea of this air which we inhale, of this hail-storm of little worlds which we perpetually encounter without apparent discomfort, let us resort to a little arithmetic and imagination—not the imagination of the poet and romancer, which delights in pictures of the fanciful and ideal, without taking much account of facts, but the healthy imagination of the scientist, which moves among the sternest of all realities, and which, if rightly exercised, becomes a potent factor in the elucidation of truth.

In this glass of water I observe a little air-bubble. It has a diameter of perhaps one thirtieth of an inch. Let us magnify this tiny bubble ten million times; let us imagine it ten million times larger than it is now, but first let us retire to a safe distance; for, the moment we touch it with our magic wand, it becomes a globe eight miles in diameter. In this globe fifty thousand billion little bullets, of the size of No. 6 shot, are flying about in all directions with the quickness of rifle-balls. Whenever one of these molecules, these shot-grains, comes in contact with another (and this happens about eighty million times every second), it is deflected from its course and takes another direction, but without the slightest loss of its original speed.

It may be asked, How can we manage to exist amid such a torrent of projectiles? we ought to be instantly annihilated. But we have forgotten to apply the same magnification-scale to our own persons. Let us do so, and we become giants seven thousand geographical miles in height. One of our feet would more than cover the distance from Chicago to New York, and with the other we could conveniently step across the Atlantic to Europe. Let the whole atmosphere be magnified in the same proportion, and it will be understood why the hail of little bullets perpetually bombarding our skin would not inconvenience us, for that skin would have a thickness of from six to eight miles. The bombardment would produce no other sensation than we now experience when a gentle breath of air fans our cheeks.

The picture which I have here presented is by no means the product of a mere fantastic flight of imagination, but a conclusion strictly warranted by mathematical facts, and necessary for the interpretation of the physical phenomena of nature.

But chemistry has to go yet one step further, in order to explain and render intelligible the phenomena of combination and affinity. We are driven to the conclusion that molecules are not the ultimate particles of matter, but are built up of still smaller bodies, the *atoms*. Thus, for instance, in a molecule of water we have two atoms of hydrogen united to one of oxygen, and all chemical processes have their source in the fact that the atoms of two or more molecules of different substances detach themselves and reunite again in a different fashion.

Now, in order to obtain a better idea of the manner in which the atoms are grouped in a molecule, we must look upon the latter as a *cluster*, the various parts of which are combined by a well-regulated movement into a harmonious system. We may well resort, for comparison, to a process within our observation, though on a far grander scale, which is admirably adapted for illustration. Let us look to our planetary system.

The planets, with the sun, represent a stable system, just as the atoms of a molecule represent such a one. In the case of our solar system, the mass of the planets, compared with that of the central body, is, of course, very insignificant. A far closer resemblance to our molecules is therefore presented by those systems of the stellar world in which two or more large bodies, of nearly the same size, revolve around their common center of gravity.

This parallel between atoms and planets, molecules and solar systems, opens before us a new and startling perspective. It affords us a glance into that unfathomable abyss which hides the mysteries of time and space, and holds in its dark recesses the very secrets of existence.

Astronomical science has shown that our sun, with the majority of the fixed stars visible to us, constitutes a great star-cluster, the diameter of which must be estimated by hundreds, if not thousands, of billions of miles. Of such star-clusters there exist a great many, which, in their turn again, form a still grander system, to which we also belong, and the boundaries of which are indicated by the outermost limits of the milky way.

How *many* of such galaxies may be hidden in the vastnesses beyond, in the bosom of infinite space, we will never know, for the light can only reach us from limited distances. Whatever may be *beyond* that very farthest nebula, the pale light of which has taken fifteen thousand years to reach us, is concealed from us forever.

But, as here in an outward and ever-enlarging scale, so in the molecules and atoms downward, and ever diminishing in size, we find system after system inclosed one in the other, like the ivory balls in a Chinese puzzle, downward, ever downward, *and there is no end!* We shall never be able to exhaust the possibilities of minuteness. The atoms of elements may consist of ether-atoms; indeed, the very elements themselves may not be elements in the true sense at all, but compound bodies, as has, indeed, been very long suspected.

Now, let us once more take our magic wand; let us imagine one of these tiny atoms enlarged to the size of this globe, of this earth, on which we live. A magnification of one trillion diameters would more than suffice. It would now, with its companion-atoms, represent a planetary system, and the molecules in a gas would stand in about the same relationship to each other as the fixed stars over us, which pursue their unknown courses; the little air-bubble in the glass of water becomes a star-cluster like the one in which our sun is situated. The circle of little bubbles around the margin of this glass would represent such a gathering of star-clusters as we now see before us in the milky way.

The galaxy in a glass of water! On what does the glass rest in which *our* starry firmament has gathered? Who will take it to his lips? We know not; we can not see beyond our tiny bubble, and the mere fact of being able to understand that we never *can* hope to look beyond it presupposes a great deal of understanding.

It will be worth our while to have a look around on our enlarged atom. We live on this planet of ours, but what entitles us to draw a line or fix a limit as to the possible or impossible in this endless, this infinite series of worlds with which we are here confronted? If we could descend on to one of these atoms, our bodies diminished in proportion, might we not, *would* we not, find there another earth grouped with its companion-atoms into a stellar system of perhaps wondrous regularity? That world in which a conscious being exists is determined by the *kind* of this consciousness, and by the character of the impressions which it is capable of receiving. We can not well think of perceptions other than our own, because we can not go beyond the limit of our own selves, but we can well imagine a world in which sensations like ours may succeed each other in far greater rapidity.

We can imagine a creature which in one second, during which we only receive at the utmost ten different impressions, is organized to receive thousands, millions, or billions. That means that in one thousandth, one millionth, or one billionth of the time *we* live, it experiences the same number of things as we do from the cradle to the grave. Its measure of time, compared with ours, would be infinitely smaller.

Such a being could live on an atom just as conveniently as we live on this planet of ours. If, for instance, the quickness of its sensations were to ours as one thousand trillions is to one, it would experience in the time of one light-vibration—that is, in one five hundred billionth of a second—as much as we in eight months. The atom on which it lived would be its world; the molecule to which the latter belonged, its solar system; and by the revolution of atoms it could count its days and years. Above him, our atom-citizen would see other similar and far-distant worlds; for, the molecules, perhaps all belonging to one tiny air-bubble, would form the star-cluster of his firmament.

A magnification of ten thousand trillion diameters would enlarge the little air-bubble to the dimensions of our entire stellar system, the star-cluster of which the limits are the outermost regions of the milky way. But, great as the host of our stars may appear to us, the firmament of our atom-inhabitant would be still more densely crowded; for while we, with the aid of our best telescopes, can not see more than about twenty million stars, the little air-bubble would harbor at least fifty thousand billions.

Now, you might object that, to an atom-inhabitant, the molecules of a gas could not possibly appear as the fixed stars do to us, inasmuch as these molecules experience, on an average, about eighty million collisions in every second. However, it must not be forgotten that we have reduced the time of life and observation of our atom-inhabitant to one thousand trillionth that of our own. During this brief moment the relative positions of the visible molecules—to him far-distant suns—will appear just as unaltered, and their courses or orbits to the atom-astronomers just as linear, as those of our fixed stars appear to us.

What is the short space of time, the trifling moment, that we know of the life-history of the earth, compared with the eternities which must elapse before two fixed stars approach sufficiently close to render a collision inevitable? Our records of human history read back only a few thousand years, and of the age of our planet we only know that it must be measured by thousands of centuries. Of the courses of the fixed stars we know absolutely nothing; we only infer from certain data that their average velocity is about a hundred times greater than that of our molecules.

Thus the atom-inhabitants are about as wise as we are. The life of the entire human race, so far as our historical records are concerned, would, if condensed to one thousand trillionth, occupy about the one thousand millionth part of a second—less than one twentieth of the time which elapses, on an average, before the collision of two gas-molecules—time enough for thousands and tens of thousands of generations of living beings to rise, flourish, and decay, before a perceptible alteration of their starry firmament can be recorded.

It remains to fancy to picture further how those atom-inhabitants imagine their world as the only world civilized and blessed by divine ordaining, for they know as little of other worlds as we do. Millions of their years may pass—by thousands the rise and fall of their nations, the dynasties of their rulers, the triumphs of their philosophers and poets may be recorded—before the water-glass with the little air-bubble, in which their planet is merely the tiniest atom, is seized by human hands, and billions of worlds are drawn in by human lips.

What an endless vista of life is here presented to us! Not enough that the vast space which surrounds us is peopled by innumerable worlds like ours, but *within* the latter *new* worlds are presented in the atoms, which in their turn again may harbor others still smaller, and so on in infinite succession.

And now the same step upward! Let us regard our *earth* as an atom, our solar system as a molecule. Of what larger body may it, with all the galaxies and star-clusters, constitute a particle? What a giant-world may *that* be, what creatures may inhabit it? *Our* universe, encircled by its galaxy of myriad suns, is it but a stray bubble floating on some mighty ocean of that greater world? This stellar system of ours, does it perhaps, in that giant-world, represent a molecule in some complicated organic structure—a nerve-cell in a giant organism, perhaps a brain-particle in the head of a Titan, whose feet rest on ground in the abysmal distances of space?

That Titan would have a height, if his body were proportional to ours, equal to a billion Sirius-distances! What thoughts, what sensations may move him, when, in his brain-cells, our suns clash in stupendous conflict and meet their doom in universal conflagration! And those Titans, whose bodies, whose *terra firma* is composed of veritable oceans of star-clusters, what a starry world may *they* behold above them! On the atoms now vibrating in our *own* brains, in the blood coursing through our veins, the destinies of nations may be fulfilled, destinies on the planets, which again are but the atoms of a higher world, destinies on the giant-worlds, and none of the beings is aware of the existence of the others; each has the solid ground beneath him, and above him the silence of the stars.

Therefore, if this thought should make us feel uneasy—the thought that this cherished world of ours is but an atom in a giant-world—let us take consolation in this: the giants are in no way better situated than we are in reference to the dwarfs which inhabit the world of atoms. Stars above them, the ground beneath them, that is *their* world as it is ours. That *we* just happen to exist on the earth is a matter of comparative indifference. No matter *where* we might be, our astronomers would always investigate the starry firmament, our chemists and physicists would divide bodies into molecules and atoms. Everywhere the suns as the atoms would pursue their courses in obedience to the same laws, everywhere two sides in the triangle would be greater than the third, and everywhere twice two seconds would make four. That is the law for the giants and the dwarfs, the law beyond which we shall never be able to rise.

EVOLVING THE CAMEL.

By GRANT ALLEN.

AS I sauntered to-day down the Rue d'Isly, on evolutionary thoughts intent, I met a caravan of camels, in long single file, coming in from the desert with their bales of merchandise. Poor, weary creatures they looked, in all conscience, their humps shrunken to mere bags of loose skin, and their patient faces bearing all too openly the marks of their long and toilsome journey across the hill country. At their head stalked a lordly Arab in a dirty white burnous; drivers and attendants of lesser station followed in the rear with a tread as stately and solemn as the camels' own. For, dejected and foot-sore though they all were, men and beasts had alike even so the free and firm step of the open desert. Little Moorish children from the dark shops ensconced in the wall ran out with childish delight and clapping of hands to see them pass; women with their faces muffled up to the eyes turned timidly to give them a casual glance; and even old Hamid Abd-er-Rahman himself, sitting cross-legged on his bench before his cup of coffee in the open bazaar, deigned to remove his pipe from his mouth one moment and remark to Omar on the divan beside him that prime dates were coming in from the oases very well this season.

As for me, standing there in my alien garb, I rejoiced in soul that I had seen a caravan, and could forthwith begin philosophizing on camels. "I could have played on any timbrel," says the poet at the Zoo, "For joy that I had seen a whimbrel." And I could have burst prosaic trammels, for joy that I had seen those camels. Everybody knows, of course, the famous story of the German student who evolved the camel from his own inner consciousness. Now, that mode of evolving a species I hold to be illegitimate; you should always draw your animal from the life, even though, like the Frenchman in the same old apologue, you only go to the Jardin des Plantes for the model on which you base your rhapsodical portrait. But when a man has actually been to Africa itself, and seen a caravan in all its glory, headed by a real live Arab in a burnous of the dirtiest, fresh from the sands and siroccos of the desert—who, I should like to know, if not he, is entitled to speak with authority about camels? For here I am, on the borders of the desert, upon whose flats I can look down (at a safe distance) from yonder mountain-heights; and if ever there was a case of "adaptation to the environment," the camel has indeed adapted himself wholly and solely to the conditions of Sahara.

Deserts, in fact, are exacting in the matter of adaptation; you must obey them or die. No other environment (not even perhaps the arctic snows) demands so much in the way of adaptiveness from all that live in it. The plants are every one of them saline and alkaline; they must content themselves with sand instead of soil, and with brackish pools instead of fresh water. The animals are all peculiar to their habitat; bird and insect must assume alike the uniform gray sabelline tint of external nature everywhere around them. Only two higher types subsist at all among those great sand-wastes—two types specially fitted for their own exceptional mode of life, one plant and one animal—the date-palm and the camel. They make Sahara. Nobody ever saw a picture of the desert without a date-palm and a camel in the foreground. Those two inseparable elements of the Africa of our fancy shall not be parted even in this sober biological sketch. Nature, indeed, has joined them together, and science shall not be permitted here to put them asunder.

And yet, though the camel as we know him is peculiarly Saharan, a product of the great African, Indian, and Bactrian deserts, it is not to the Old World that we must look at all if we wish to evolve the camel historically, rather than to develop him by *a priori* process from the depths of our own inner consciousness. It is America that gives us geologically the earliest evidence of the camel's ancestors; and it is America that still contains the greater number of species of the camel family, in the persons of the llama, the alpaca, the guanaco, and their allies. Prof. Cope has drawn up the pedigree of the race for us in full detail. The Asiatic and African camels, in fact, are mere surviving Oriental members of a family American in origin and history, but stranded, as it were, in a remote corner of the Old World, where they have survived the competition of newer and higher types in virtue of their special minor adaptations to the peculiar circumstances of their strange habitat. Having early fitted themselves in certain outer points to desert conditions, they have been enabled to outlive all their younger and more highly developed competitors solely in virtue of their singular combination of desert-resisting qualities.

Now, it must at once strike everybody as a curious circumstance in the geography of animals that the existing cameloids should be so strangely distributed—one group of them in the desert region of Asia and Africa, the other group away across the world among the snowy slopes of the Andes of South America. What can be the meaning of so quaint a freak of distribution? Why should the two surviving cameloid tribes be thus separated from one another by half the earth's surface, and by many deep seas and shadowy mountains—one in the Old World and one in the New; one in the desert and one in the uplands; one in the northern hemisphere and one in the southern? Clearly, the answer suggested alike by geological facts and by analogies elsewhere, is simply this: we have here, as it were, two little surviving biological islands, colonies of an ancient race which once covered both worlds alike with its numerous members. Time was when the camels or their allies were of cosmopolitan distribution. They ranged, no doubt, the Eocene plains of all the great continents. But they are an ancient and in many respects an undeveloped ungulate form, which has become extinct elsewhere in the intermediate regions through the fierce competition of the higher ruminants, and has lingered on only under special circumstances in two remote corners of the world—in the deserts of Arabia and in the Andes of Peru.

The llamas and alpacas, as the lower and less specialized type of the two, explain best the true systematic position of the family. For South America, as everybody knows, is in many respects a very antique biological province. Less ancient in its life-forms than Australia, that world of living mesozoic fossils, it yet retains in many places the scattered remnants of its extremely old-fashioned fauna. There is reason to believe, indeed, that the circumpolar continent—Europe, Asia, and North America—was once for many ages continuous, while Australia, South Africa, and the South American peninsula formed separate islands in a wide and winding southern sea. Hence the higher life-forms developed rapidly in the broad and varied northern land-mass, while more antiquated types continued to live on, uninfluenced by their competition, in the three isolated southern provinces. Of these three, Australia alone still remains a great island; but South Africa has been joined to the Mediterranean world by a gradual upheaval of the Saharan area; while the Isthmus of Panama, still later in date, apparently, has formed a great natural bridge by which some of the North American land-animals have been able to invade the comparatively unpeopled tropical realms of the low southern species. In both cases, however, many of the low local types still hold out in extreme recesses or under special climatic and geographical conditions; and thus the llama and alpaca have been preserved to our time intact in the narrow belt of temperate slope between the snow-clad Andes and the Pacific shore.

I have said that the cameloids are a very ancient type of ruminants indeed: their skeleton abundantly proves this fact; but I will not dwell at length upon such dry points of anatomical detail, because I fancy I have noticed on various occasions that the general public does not wildly interest itself in questions of carpal and metatarsal bones. It is not frantically enthusiastic about distinctions of odd-toed or even-toed ungulates. What most of us really want to know, and what the comparative anatomists as a body still studiously neglect to tell us in plain language, is how each animal came to obtain, not its bones which we don't see, but its distinctive external shape and characteristics—its horns, its tusks, its hump, or its antlers. We would rather learn a few simple facts about the evolution of the elephant's trunk or the peacock's tail than a whole volume of learned memoirs on the cervical vertebræ and the carinate sternum. Those things are doubtless very convincing in their own way, but they are not of a sort to rouse our profound personal attention. There are, however, two other visible points about the camel-kind which clearly mark their true position as very early ruminants indeed, and which can yet be readily apprehended by the ordinary surface-loving, non-anatomical intelligence. One is, that the camels as a group antedate the development of horns or antlers; the other is that they still possess in full, like other animals, those canine and incisor teeth which are partly obsolete, partly altered in shape, in all the higher and later ruminants. Each of these peculiarities has a meaning of its own, and points back to certain interesting episodes in the development of the great ruminant order.

The vast mass of ruminants generally at the present day possess some form or other of horns or their equivalents. In the giraffe, which in a few points (mostly delusive) approaches the camels, the horns are merely blunt protuberances of bone, persistent through life, and covered with a continuous hairy skin. They show us the lowest surviving stage in the evolution of frontal weapons. In the deer tribe, they appear at first under much the same form, as little knobs or bosses of bone on the forehead, underlying a fold of skin technically known as the velvet; but when the horns are fully grown, the velvet is rubbed off, and the bone alone shows its naked material as the branching antlers with which we are all so familiar in the Scotch red deer. Horns of this type are shed annually, and reproduced in more and more complex forms (representing successive ancestral stages) with each renewal. Finally, in the great central group of the ruminants, represented in our day by the oxen, sheep, goats, and antelopes, the bony core or heart of the horn is protected by a sheath of agglutinated hair, which continues to increase by layers during life. This last form of horn is never shed, but persists through the whole of the animal's existence.

Historically, we know that the earliest ruminants, whose remains are preserved for us in Tertiary strata, were quite hornless; and the gradual evolution of horns and antlers, from the simplest to the most complex, has been traced out in full through successive geological ages by Gaudry, Boyd Dawkins, and other biologists. We can follow in detail the origin and rise of each tine and spike from the mere boss or knob on the forehead of the ancestral form to the branching horns of the reindeer, the wapiti, and the Irish elk. The camel, therefore, in its lack of horns represents for us an early undeveloped stage of the ruminant type, when the ruminants had as yet only just diverged from the common ancestors of the horses and pigs. Darwin has shown that horns and other familiar offensive weapons (especially when peculiar to the males alone, as is the case with the antlers of stags) have been developed in the struggle for mates, and are a necessary result of sexual selection. But all such ornaments belong to the higher and later stages of animal life, and are wholly wanting in the unarmed, undecorated, ugly camel. He is, in fact, a ruminant on which the higher types of selection have been little exercised, though, as we shall presently see, his special adaptations for a desert-life have been carried very far in particular directions, and so have enabled him to hold out bravely in his own narrow and restricted field against all more advanced and more highly specialized animals.

The teeth of the camels and of their allies the llamas tell the same tale in a somewhat different fashion. In all the higher ruminants—giraffes, deer, oxen, antelopes, and goats alike—the weapons of offense are the horns or antlers, and the teeth have almost or entirely ceased to be used in fighting. They have also undergone certain profound modifications of shape and arrangement (interesting only to the technical anatomists), which fit them for cropping grass or other low herbage, but get rid to a great extent of their tearing powers. On the other hand, there is one other group of ruminants besides the camels which is destitute of horns —the little group of musk-deer—and in these pretty, small creatures the canine teeth have been developed into long protruding tusks, which thus take the place of horns as offensive weapons, and are used by the males in their single combats for the possession of their mates. But, in the camels and llamas, no special fighting-weapon of any sort exists. When camels fight at all—which is very rarely—they fight merely by simple biting. They remain in this respect on the lowest mammalian level. Their teeth approximate rather to the type which occurs in horses and some other outlying ungulate groups than to the type which occurs in the true ruminants. They have always canines in both jaws; but these canines are not lengthened out into regular tusks, nor do they serve to any noticeable extent as weapons of warfare. In short, the camels by many points of their structure point back to a time when the ancestors of the ruminants had not diverged at all widely from the ancestors of the horse, the pig, or the hippopotamus, and they still retain in many particulars the early "generalized," or rather unspecialized, type of the common progenitor of the entire group.

The llamas and alpacas may be looked upon as the best living representatives of the camel tribe in its primitive state, before it had begun specially to assume its camel-stage. They do not possess the adaptive peculiarities which fit the camel for its desert existence; and, on the other hand, they exhibit to the full that awkward, ungainly, misshapen type which so often betrays Nature's first rough draught of an evolving order. They are, as it were, the sketchy outline only of the perfected ruminants. Compare for a moment the ugly, shambling, ungraceful alpaca with the red deer, flying over the open Scotch moorland; the gazelle, springing lightly along the Syrian plains; the antelope, careering across the South African veldt; or the chamois, leaping from crag to crag among the frozen Alps, and you will see at once what is meant by the difference between a specialized and a generalized type—the difference between Nature's early attempts in a given line, and her fully evolved and carefully molded final product.

The antelopes and deer, with their various allies, such as the gnu, the eland, the ibex, the buffalo, the bison, the sheep, the big-horn, and the musk-ox, represent for us the developed ruminant types, produced by fierce competition in the struggle for life in the great continents. Their fleetness of foot, their exquisite horns, their agility, their grace of movement, all depend upon the existence in their native countries of highly evolved beasts of prey, from whose fierce attacks they have had to save themselves by speed and acuteness. To the same cause they owe also the keenness of their senses, the slimness of their legs, and to some extent also the elegance and beauty of their entire bodies. The smaller kinds, like the gazelles, are remarkable for their vigilance, their timidity, and their alertness, the hereditary result of ages spent in avoiding the attacks of predatory enemies. Natural selection, in short, has given to the advanced ruminants generally their distinctive rapidity, lightness, and beauty of shape. To sexual selection, on the other hand, they owe their twisted horns or branching antlers, their dappled coats and exquisite markings, their ornamental manes and their proud and stately gait and carriage. All these points are wholly wanting in the clumsy llama and alpaca group. Stranded remnants, as it were, of the Eocene world, those antique creatures linger on among their mountain valleys a perpetual milestone by whose indications we may mark the progress since effected, under stress of selective agencies, in the main advancing body of the higher ruminants.

On such a simple original type, defenseless and ungainly, the camel is a specialized and adapted desert variation. The undeveloped llamas have no humps, and they have their two toes quite separated in a certain awkward, ungraceful, splay-footed fashion. In the true camels, on the other hand, the two toes are united below by a kind of horny sole, almost to their points, which terminate in a couple of small hoofs, and beneath the foot there is a soft cushion, by which the instep bears upon the sandy soil over whose expanses the creature is adapted to move. This padded sole is to the camel what the solid hoof is to the horse, it fits him exactly for the sort of ground over which his ancestors have stalked and shambled for countless generations. And it is interesting to note the similarities and differences which natural selection has brought about in the case of these two chief human beasts of burden.

In both the foot has become adapted for scouring the open plain only; firmness and sureness of tread have been the sole qualities that really told, and hence, in both, the toes as such have become practically extinct, and in their place one gets at last a single united broad-based foot, such as gives the animal the most secure foundation for his heavy body upon the level ground.

Compare for a moment these two types of practically toeless foot with the grasping hand of the forestine monkeys, the sharp claws of the tree-haunting squirrels, the light paw of the leaping hare, or even the slender and delicate ungulate feet of the gazelles and the chamois, and you will see how wholly they have been specialized for their work as trotters only. In the ruminants generally, as in all the great division of hoofed mammals, the extremities are calculated for support alone; but in the horse and in the camel this restriction of function reaches its highest practical point, and the feet and legs exist merely as adequate and extremely stable props for the heavy framework. In the horse the solid hoof remains as the sole surviving toe out of the original five possessed by his primitive ancestors in the American Eocene (though the "splint-bones," well known to the veterinaries, are the last functionless relics of two other toes); in the camel the same result is practically attained by the union of the two toes which it still possesses through the medium of a single horny sole, as well as by throwing the main weight of the body on the padded cushion underneath the instep.

On the other hand, in the horse, adapted as he is by nature for scouring open, grassy plains or hill-sides, natural selection has favored the development of a particularly hard and solid hoof, whose native qualities man still further exaggerates by shoeing him with a clanking ring of iron; while in the camel, the direct product of desert conditions, a singular softness and pliability of foot has rather been encouraged by the soft and shifting nature of Saharan or Bactrian sands. For this reason, it is found practically that the horse and the camel are in any given country mutually exclusive; where the one thrives the other languishes. Here, in northern Africa, outside the Atlas, camels can not be profitably employed as beasts of burden; the few that come here in caravans from the desert arrive with a weary, foot-sore, dejected look, tired of tramping with their soft-padded feet over the hard and smooth macadamized roads which the French engineers have substituted for the narrow, paved Moorish packways, where mules and Arabs once transacted in their slow and lumbering fashion all the business of Algeria and Tunis. But beyond the shallow belt between the mountains and the sea the horse is of no avail: his hard and unyielding hoof sinks deep into the shifting sand of the desert, and he struggles and shuffles in helpless despair where the light dromedary, with his loose, shambling gait, his long trot, and his padded sole, fitting itself accurately to the sand beneath, accomplishes with ease his hundred miles a day for a week together. On hills or rocks the camel is nowhere, on open sandy plains he can hold his own against all comers.

It is interesting to note, indeed, how much alike in many adaptive particulars, but especially in their awkward gait, their tall necks, their long, shambling swing, and the powerful flanks which bring it about, are the three chief inhabitants of the desert or its outskirts—the camel, the giraffe, and the African ostrich. In the last-named case, the likeness is all the more curious and striking because one would almost have said beforehand that to adapt a bird and a ruminant mammal to the same environment, and to turn them out at last with many striking external resemblances of shape and gait, would be simply impossible; and yet Nature has accomplished this strange feat so perfectly that Linnæus, struck by the singular analogy between the two creatures, gave the ostrich the scientific name, which it still bears, of *Struthio camelus*. Even the reduction in the number of the toes to two, and their provision with a soft pad underneath, have been accurately reproduced in the great bird. As to the giraffe, its old name of camelopard sufficiently attests the popular appreciation of its outer similitude to the ship of the desert. The fact is, no large animal can be properly adapted for Saharan conditions (liability to attack from lions and other great beasts of prey included), unless it combines these three attributes of a soft tread, a swift, swinging gait, and a long neck, enabling it to reach its food above or below, as necessitated by the height of its legs and body. Ostriches, giraffes, and camels alike, all feed to a considerable extent indeed on foliage of trees.

Of all these animals, however, the most purely desert-haunting is the camel itself, and it exhibits, therefore, a few special peculiarities not equally well developed in any other creature. In the first place, desert journeys imply continued privation, or even at times complete absence of food. Now, whenever in the animal kingdom such a necessity frequently arises in the ordinary life-history of a species, natural selection has provided against it by favoring the survival of those individuals which can lay up spare material against the period of famine in their own tissues. A starving sheep, Prof. Huxley well remarks, is as much a carnivore as the lion that would devour it; it subsists strictly upon its own fat and its own muscle, which it slowly unbuilds to use up in the needful action of its heart, its lungs, its limbs, and its internal organs generally. Hence, in hard times, those animals which have the largest reserve-fund of fat at their disposal will survive longest, and species which often encounter hard times learn organically by hereditary experience to supply such a reserve-fund against possible contingencies. Thus the bear and the dormouse go to sleep sleek and plump for the annual hibernation, and wake up mere loose and baggy masses of skin and bone. The zebu and other tropical oxen gather a huge hump of fat between the shoulders in the wet months while grass is plentiful, to serve them as a store of food during the dry season. But in the camel and dromedary this special provision against famine reaches the highest point, and produces the hump or humps on the back—one in the Arabian or African, two in the Bactrian or Indian variety.

Structurally, of course, the humps are nothing—mere lumps of fat, collected under a convenient fold of the skin, and utterly unprovided for in the framework of the skeleton. When the animal is at its best and well fed, they are full and plump, standing up on his back firm and upright; but on a long journey they are gradually absorbed to keep up the fires that work the heart and legs, and in the caravan camels which arrive at the coast, the skin hangs over, an empty bag, upon the creature's flanks, bearing witness to the scarcity of external food during the course of his long, forced march from the interior. A starved small camel in this state of health far more closely resembles a Peruvian llama than any one who has only seen the fine, well-kept beasts in European menageries or zoölogical gardens could readily imagine.

But water is even scantier in the desert than food; and against want of water, therefore, the camel has had to provide himself, functionally at least, if not structurally, quite as much as against want of herbage. His stomach has accordingly acquired the power of acting as an internal reservoir, and he can take in as much water at the Bahrs or Wadys, where he rests for a while on his toilsome march, as will supply his needs for four or five days together. There are some differences in this respect, however, between the two chief varieties of the camel. The African kind is most abstemious, and best adapted to sandy deserts; the Bactrian, a product of more varied and better-watered country, is larger and stronger, but less patient of hunger and thirst, while at the same time it can manage to subsist and to make its way into somewhat rockier and more rugged country.

One other adaptive peculiarity the camel possesses which marks it out essentially as a desert-born animal, modified for generations by the baking expanse of Sahara or the Arabian sand-wastes. On those scorching surfaces a horse could not lie down to rest in the eye of the sun without scalding or excoriating his tender skin. But all the parts of the camel's body which touch the sweltering sand in his ordinary patient kneeling position are provided with callosities of thickened hide, which enable him to rest on the burning surface without danger or discomfort. The only other desert-haunting ruminant of similar habits, the giraffe, has analogous callosities for the same purpose on his breast and knees. Such adaptive characters, however, are never a key to real relationship; they necessarily result from mere exposure to the same circumstances; and hence we get the seemingly paradoxical principle, so well enunciated by Mr. A. R. Wallace, that the more useful any organ or point of structure is to its possessor, the less is its value as a test of systematic position. Unseen little bones and internal organs, which fail to strike the imagination of the outside observer, are rightly used as the keys to underlying relationship by the systematic biologist. The real affinities of the camel are closest, indeed, not with the giraffe which so strongly resembles it, but with the llama and alpaca, so remotely connected in outer seeming, and so widely separated from it in space by an entire hemisphere.

Camels, llamas, and alpacas alike, then—to sum up the conclusion to which we have all along been tending—represent a very simple and early ruminant type, unmarked by any of those higher features induced in the ruminants of the open plains of the great continents by the necessity for protection from the advanced carnivores. They recall for us in their main points of structure, as well as in their low and undeveloped grade of intelligence, the general characteristics of the ruminant race at the dawn of its existence in the Eocene period. They have no horns or tusks or weapons of offense, such as grow up in the savage battles of the males among dominant races; and their very docility and gentleness of demeanor result in the last resort from this undeveloped character of their entire class; for non-fighting animals are always timid, patient, and inoffensive, though often obstinate and self-willed to a noteworthy degree, as the camel can be whenever he chooses. Their virtues themselves thus tell against them; they betray the stupidity and the archaic, unprogressive character of the whole type. The *camelidæ* as a group, in short, are surviving specimens of the raw material from which, by natural and sexual selection, the higher ruminants, in diverging lines, have been slowly evolved through innumerable ages.

But of this antique and unspecialized type, the camel itself is in certain ways a highly modified and peculiarly adapted desert offshoot. Retaining still in its internal structure the marks of its early undeveloped character, it nevertheless presents in external configuration and functional peculiarities a remarkable instance of special adaptation to a restricted environment. While as a ruminant it is extremely low, as a desert animal it is at the very top of the tree. And it is this early adaptation to a very unusual mode of life that has enabled the camel, lowly as it is in general organization and in intellectual grade, to hold its own successfully against all later comers, and to preserve for us still in the great central Eurasiafrican continent a type of life otherwise extinct save in a single outlying and practically insulated district of the old South American life-region.—*Longman's Magazine.*

BELIEFS ABOUT THE SOUL.

By R. A. OAKES.

FROM the standpoint of primitive man it seems impossible for him to escape the conviction of a plurality of souls or the belief of their survival after death. Troubled by no psychical problems, accepting all things with an unreasoning faith, the phenomena of dreams, of coma attending swoons, of apoplexy, and of kindred afflictions, are explicable only on the supposition of a plural soul. He lies down on his rude couch, closes his eyes, and in an instant is living over the scenes of his daily life. He visits again far-distant hunting-grounds, renews once more the joys and fatigues of the chase, indulges in his savage warfare, and encounters adventures at once weird and abnormal. The dead—those who have for years been moldering in the earth—come back and speak to him, and renew once more the pleasures of his social life. His body lies immovable, life and warmth remain with it, his breath comes and goes, his pulse throbs as in his waking hours, but he in the mean time has traversed leagues and leagues of forests, crossed broad rivers, scalped an enemy, or killed some savage wild beast. Upon the supposition of a dual soul, the mystery of his sleep is at once explicable. While one soul stays and watches over the body, the other soul has gone out to roam over the world at will.

This explanation of dreams seems to have received wide-spread recognition alike with the early civilized and savage races of men. The Chinese thought that the soul in dreams went out in a nightly ramble even to foreign lands. One day when the "spiritual man" of T'ih Kwalee, one of the gentry, was out roaming around, a wild beast found his body and ate it; so, when the spirit returned, it found only the skeleton, but fortunately near by was a beggar's corpse, black and lame; this he took as a substitute for his own body, and always afterward walked with a staff.* The Japanese believe that, if a sleeper is wakened suddenly and violently, he will die, because his soul is then rambling at a distance, and can not return to the body in time before it is awakened. This soul is supposed to have form and color, and to be a small, round, black body, and its adventures, when in the disembodied state, form a standard subject for Japanese novels and imaginative literature.† Pliny tells us that the soul of Hermotinus, one of the embodiments of Pythagoras, was in the habit of leaving his body and wandering into distant countries, whence it brought back numerous accounts of various things which could not have been obtained by any one but a person who was present. The body in the mean time was left apparently lifeless. At last his enemies burned the body, so that the soul on its return was, as it were, deprived of its sheath.‡ St. Augustine tells the story of a man who visited another and expounded a certain passage in Plato which formerly he had refused to do, and afterward, when questioned why he had changed his mind, denied that he had, but admitted that in a dream he had expounded the passage.# At the Temple of Isis, in Alexandria, an Egyptian priest, in the presence of Plotinus and his disciple Porphyry, drew a magical circle on the ground, decked out with the customary astrological signs, and then invoked from the body of Plotinus his own soul, so that he stood face to face with it.‖ Goethe ^ positively asserts that he

* Du Bose, "Dragon, Image, and Demon," pp. 369, 422.

† Griffis, "The Mikado's Empire," p. 472.

‡ "Natural History," vol. vii, p. 53.

"De Civitate Dei," vol. xxviii, p. 18.

‖ Draper, "Intellectual Development of Europe," vol. i, p. 404.

^ Elam, "A Physician's Problems," p. 336.

had a similar experience. Aristophanes * tells us that Pisander betook himself to a certain lake to see his own soul, which had deserted him, evoked by Socrates.

The belief of savages in the possibility of the soul leaving the body during life has been widely traced. In western Africa, when a man wakes up with a pain in his body or muscles, it is because his spirit has wandered abroad in the night and been flogged by some other spirit.† The Feejeeans believe that the spirit of a man will leave the body to trouble other people when asleep, and, when any one faints or dies, his spirit can be brought back by calling after it.‡ Du Bose # tells us that in China often at night is heard the weird sound of a man calling back the body of a sick child. In the streets a cloth will be spread on the ground, with some beans thrown on it. An old woman stands by it, and calls the child by name: "Ah, do come back!" A voice up-stairs responds, "Ah!" Or the mother goes in front with a lighted lantern in hand, burning paper money at every corner. The father follows with the sick boy's clothing in his hat, crying, "My son, come back, come back!" An insect on the roof is caught, folded nicely in paper, and put beside the sick boy's pillow, and thus the lost soul is found. Sickness comes from losing his soul, and recovery follows its return home. Le Clerc recounts a story, current among the Algonquins, of an old Indian chief, whose favorite son having died, journeyed to the land of souls for his recovery. When once there, he begged so hard for his son's soul that the Indian Pluto finally gave it to him in the form and size of a nut, which, by pressing between his hands, he forced into a small leathern bag. Instructed to place the soul in the body of his son, who thereupon would come to life, the happy father hastened back, where he was greeted with dancing and rejoicing. Wishing to take part in these festivities, he handed the boy's soul for safe-keeping into the hands of a squaw. Tempted by a curiosity which has proved so fatal in all religious cults, the woman opened the bag to peep into it, when the soul escaped and returned to the land of the dead.‖ Turner ^ tells us that the soul of the chief Puepuemai was wrapped up and carried around in a leaf. The Ojibways describe how one of their chiefs died, but, while they were watching the body on the third night, his shadow came back into it, and he sat up and told them how he had traveled to the river of Death, but had been stopped there and sent back to his people.◊ The Malays do not like to wake a sleeper, lest they should hurt him by disturbing his body when his soul is out.

* "The Birds," p. 1553.

† Wilson, "Western Africa," chap. xii.

‡ Williams, "Fiji and Fijians," vol. i, p. 242.

\# "Dragon, Image, and Demon," p. 443.

‖ Parkman, "Jesuits of North America," p. lxxxiii.

^ "Samoa," p. 142.

◊ Tylor, "Anthropology," p. 344.

Sir John Lubbock * has traced this belief in the power of the soul to leave and return to the body to the inhabitants of Madagascar, the Veddahs of Ceylon, the Mangaujas of South and the Yorubans of West Africa, the Tongans, the Peruvians, and other tribes.

Frequently the soul in its mundane journeyings took the visible guise of some animal. Grimm † tells us how King Gunthram's soul, while he slept on his faithful follower's lap, came out of his mouth in the form of a snake, and attempted to cross a stream. To aid the snake, the henchman bridges the stream with his sword, when it passes over, goes up a hill, and, after a little, returns and enters the king's mouth. Presently the king wakes, and relates how in a dream he had crossed an iron bridge, and entered a mountain filled with gold. Claud Paradin, ‡ in his "Symbola Heroica," has a variant of this wonderful dream, accompanying the legend with an engraving of a sword with a small animal—possibly a mouse—standing on the blade, and the motto "*Sic sopor irrupit.*" In this variant the king returns to his palace and summons all the wise men of his kingdom to interpret the dream, and for once in the world's history the opinions of the *savants* were unanimous. A large treasure was concealed in the hill, and its existence was thus revealed by a miracle.

Hugh Miller # illustrates the Celtic theory of dreams by a similar legend. Two young men sitting on a mossy bank overhanging a small cascade, one of them, overcome by the heat of the day, falls asleep, when his companion is surprised to see issue from his mouth a little indistinct form scarcely larger than a humble-bee, which disappears over the cascade. The watcher in alarm tries to waken his companion, but, before he succeeds, the cloud-like creature returns and enters the sleeper's mouth. Then he opens his eyes and relates a wonderful dream; how he crossed a broad river on a bridge of silver, and found on the further shore heaps of gold and jewels. It is more frequently the guise of a mouse that the wandering soul delights to masquerade in, though according to Grimm ‖ it is the devil's brides out of whose mouths the soul runs in the shape of a red mouse. Thus we are told that in Thuringia a servant-girl fell asleep while her companions were shelling nuts, when they observed a little red mouse creep out from her parted lips and run out of the window. One of those present then shook the sleeper, but, not succeeding in waking her, moved her to another place. Presently the mouse ran back to the former place, and dashed about, seeking the girl, but, not finding her, it vanished, when the girl instantly died.^ A miller, cutting fire-wood in the Black Forest, fell asleep over his work, when

* "Origin of Civilization," p. 214 *et seq.*

† "Teutonic Mythology," vol. iii, p. 1082.

‡ Chambers's "Book of Days," vol. i, p. 276.

\# "Schools and Schoolmasters."

‖ Grimm, *loc. cit.*

^ Baring-Gould, "Curious Myths," p. 424.

his man saw a mouse creep out of his mouth and run away; every one searched for the animal, but could not find it, and the miller never awoke.* In Bohemia it was considered dangerous to go to sleep while thirsty, as the soul was sure to wander abroad in search of water. Baring-Gould † tells the story of three laborers, having lost their way in the woods, and, parched with thirst, seeking in vain for water. At last one of them lay down and fell asleep, while the others continued their search until they found a spring. After drinking they returned to their comrade, when they saw a little white mouse run out of his mouth, go to the spring, drink, and then return to the sleeper. In German superstition the souls of the dead assume the forms of mice, and when the head of a house dies it is said that even the mice of the house abandon it, and that, in general, every apparition of mice is considered a funereal presage; the funeral of St. Gertrude, represented surrounded by mice, being thus accounted for.‡

The position of the mouse in the folk-lore of the soul is not quite clear. The Mojaves believe that curling upward with the smoke from the funeral pyre the soul rises and floats eastward to the region of the rising sun; but, if its purity has been sullied with crime or stained with human blood, it is transformed into a rat and must remain four days in a rat-hole to be purified before it can share the joys of heaven.# Mr. Ralston‖ tells us that in the Nijogorod Government the Milky-Way is called the Mouse-Path, the mouse being a well-known figure of the soul. Miss Phipson△ says that the dormouse, from its awakening from sleep with the return of spring, was sometimes employed in ecclesiastical art as a type of the resurrection. *Per contra*, Mr. Conway ◊ assures us that the shudder which some nervous persons feel at the sight of even a harmless mouse is a survival of the time when it was believed that in this form unshriven souls or unbaptized children haunted their former homes, and from the many legends that report the departure of unhallowed souls in the shape of this timid creature.

Birds vie with mice in the honor of being human soul-bearers. The heathen Bohemians thought that the soul flew out of the mouths of the dying in the shape of birds. Grimm ‡ says such ideas were common in pagan Scandinavia. In the Edda of Sæmund it is said that souls in the form of singed birds flit about the nether world like swarms of flies. The Bohemians thought that bird-shaped souls flew restlessly from tree to tree until the bodies were

* Grimm, *loc. cit.*

† "Curious Myths," p. 461.

‡ De Gubernatis, "Zoölogical Mythology," vol. ii, p. 67.

\# Bancroft, "Native Races of the Pacific Coast," vol. iii, p. 526.

‖ "Songs of the Russian People," p. 109.

△ "Animal Lore," p. 131.

◊ "Demonology and Devil Lore," vol. i, p. 128.

‡ "Teutonic Mythology," vol. ii, p. 828.

burned, when they had rest. The Finns and Lithuanians and later nearly all Indo-European people called the Milky Way the Birds' Way—that is, the way of souls.* The Moslems say that the souls of the faithful assume the form of snow-white birds, and nestle under the throne of Allah between death and the resurrection.† Another account says that in the intermediate state, until the resurrection, the souls of martyrs, according to tradition received from Mohammed, rest in heaven in the crops of beautiful green birds who eat of the fruits and drink of the rivers in that charmed region.‡ In China on the twenty-first day of the period of mourning for the dead three large paper birds resembling storks are placed on high poles in front of the house of mourning. These birds are supposed to carry the souls of the departed to Elysium, and during the next three days prayers are addressed to the ten kings of the Buddhist hades calling on them to hasten the flight of the departed soul to the Hindoo paradise.# On the Bosporus flocks of birds about the size of a thrush fly up and down the channel, and are never seen to rest on sea or land, and are believed by the boatmen to be the souls of the damned, condemned to perpetual motion.‖ Pliny^ tells that it is stated in Proconnesus that the soul of Aristeas was seen to fly out of his mouth under the form of a raven. The Aztecs believed that the souls of those killed in battle, of prisoners sacrificed by the enemy, and of women dying in childbirth, went to the sun, where they passed four years of delightful existence. They were then turned into birds and animated the clouds with their brilliant plumage and harmonious voices, free to rise to the vaults of heaven or to descend to earth to taste the nectar of the flowers.◊ When a Kailta dies it is thought that the soul is carried to the spirit-land by a little bird, and, if it has been a wicked soul, it is overtaken on the way and devoured by a hawk or other bird of prey.‡ Among the Apaches the owl, the eagle, and perfectly white birds were regarded as possessing souls of divine origin.↕ The Maricopas believe that after death they will return and live in their ancient homes on the banks of the Colorado River, where their heads will be turned into owls and the other parts of their bodies into different animals.‡ The Icannas of Brazil think the souls of the

* Kelley, "Indo-European Folk-Lore," p. 103.

† Brewer, "Dictionary of Phrase and Fable," p. 840.

‡ Koran, Sale, "Preliminary Discourse," section 4; Alger, "Future Life," p. 201.

\# Jones, "Credulities," p. 373.

‖ Hardwick, "Traditions, Superstitions, and Folk-Lore," p. 158.

^ "Natural History," vol. vii, p. 53.

◊ Bancroft, "Native Races," vol. iii, p. 533; Alger, "Future Life," p. 73; Biart, "The Aztecs," p. 86. ‡ Joaquin Miller, "Among the Modocs," p. 241.

↕ Schoolcraft, "Archæology," vol. v, p. 209.

‡ Bartlett, "Personal Narrative of Exploration," vol. ii, p. 222.

dead become beautiful birds feeding on luscious fruit.* The Powhatans sacredly regard small wood-birds, thinking they inshrine the souls of their dead. † Among the Aht tribes it is believed that the soul issued from gulls and partridges, and that they will after death return to their original forms.‡ The Hurons, according to Brebeuf,# believed that the souls of the dead turned to doves; and among the cognate tribes of the Iroquois a dove was freed over the couch of the dying at the moment the last breath was drawn.‖ The Paris "Figaro" for October, 1872, gives an account of a similar observance as happening in the Rue Duhesme of that city. A young gypsy woman when dying was surrounded by her companions, when a man, who appeared to be the chief, entered the circle, carrying a bird in his hand, which he held beneath the mouth of the dying, and freed when she expired.^

The providing the dead with passports or money with which to lighten the journey of the soul to heaven is wide-spread. The Greeks placed an obolus in the mouth of the corpse, as toll for Charon, though this offering was omitted at Hermione, in Argolis, where men thought there was a short descent to hades, and thus avoided the fee.◊ Becker ‡ doubts if this custom was universal among the Romans, the passages of Juvenal, vol. iii, p. 67, and of Propertius, vol. iv, pp. 11, 7, affording no sufficient proof. Among the Chinese, money was put into the mouth of the dead to buy favor in the passage to heaven.↕ In Washington Territory, in 1879, the mouth of a dead Twana squaw was filled with money before burial.‡ At the present day, all over Europe at Irish wakes money is placed in the hand of the dead.** In Tuhkeim, the soul of the dead, having crossed the bridge leading out of hell with the aid of the priests, receives a letter of recommendation from them favoring its admittance into the western heaven.†† The dead of the ancient Mexicans were furnished with several passports, the first one enabling the soul to pass between two mountains, which threatened to meet and crush it in their embrace; the second enabling it to pass the road guarded by a big snake; the third propitiated Xochitonal, the green crocodile; and the fourth insured the passage across eight deserts and over eight hills. ‡‡

That the soul materializes in the shape of the body it inhabited

* Clavigero, "Messico," vol. ii, p. 5.

† Brinton, "Myths of the New World," p. 107.

‡ Bancroft, "Native Races," vol. iii, p. 522.

◊ Tylor, "Primitive Culture," vol. i, p. 490.

↕ Ball, in Williams's "Middle Kingdom," vol. ii, p. 244, note.

‡ "American Antiquary," October, 1880, p. 53.

** Tylor, "Anthropology," p. 347.

"Rel. des Jesuits," 1636, p. 4.

‖ Morgan, "League of the Iroquois," p. 174.

^ Jones, "Credulities," p. 380.

‡ "Gallus," Excursus xii.

†† Du Bose, "Dragon, Image, and Demon," p. 452.

‡‡ Bancroft, "Native Races," vol. iii, p. 537.

while on earth is one of the tenets of modern spiritualism. The Chinese believe that decapitation makes headless souls in hades. During the T'aiping troubles as much as six hundred and sixty-six dollars was paid for a head to be buried with a body, in order to make a respectable appearance in the other world! * The Australian who has slain his enemy will cut off the right thumb of the corpse, so that it can not throw the ghostly spear with the mutilated hand. A West India planter, whose slaves were committing suicide in order that they might come to life in their native land, cut off the heads and hands of the corpses, thus effectually putting an end to the practice.† In China the souls of the drowned are supposed to remain under water for three years, when they seize the shadow of some passing man, pull him in, and thus effect their own escape. Boatmen are in continual dread of these demons, and stone pillars are erected on the spots where they were drowned in order to control their souls.‡ Damascius tells us that, in a battle fought near Rome by Valentinian against Attila, the slaughter on both sides was so great that none escaped, and, when the bodies had all fallen, the souls still stood upright and continued fighting three whole days and nights, neither inferior in activity of hands or fierceness of mind to living men. The images of the soul were seen and the clashing of their armor heard.#

The idea of the plurality of the soul is met with in the oldest records of man, and is universally accepted by savage tribes to-day. The Egyptians considered man to have a soul, *ba*, represented by a hawk with a human head; a shade, *khebi;* a spirit or intelligence, *khu*, into which it became changed as a "being of light"; an existence, *ka;* besides life, *ankh*. The soul, *ba*, only revisited the body.‖ The Hebrews have *nepesh*, the animal life; *ruah*, the human principle of life; and *neshamah*, life considered as an inspiration of the Almighty, and from these the Rabbins taught the threefold nature of the soul.^ The Persians divided the soul into five parts: The *feroher*, or sensation; the *boo*, intelligence; the *rough*, imagination, volition; the *akho*, conscience; and the *jan*, animal life. Of these, the first one alone was accountable for the deeds done in the body.◊ The Chinese believe in three souls and six spirits: the latter, being animal, go down into the earth at death, while, of the souls, one goes down into

* Williams's "Middle Kingdom," vol. ii, 244.

† Tylor, "Primitive Culture," vol. i, p. 451.

‡ Du Bose, "Dragon, Image, and Demon," p. 454.

\# Southey, "Commonplace-Book," vol. i, p. 287.

‖ Birch, in Wilkinson's "Ancient Egypt," vol. iii, p. 465, note.

^ Farrar, "Language," p. 188.

◊ Fraser, "History of Nadir Shah"; cf. Emerson, "Indian Myths," p. 179.

hades, the second enters the coffin, and is laid in the grave, but is not satisfied with its dismal abode; while the third lingers around its old home, and with the second soul receives the worship of its posterity.* The Hindoos designate between *Brahmâtmah*, the breath of God, and *jivâtmah*, the breath of life.† The Khonds of Orissa have a fourfold division of the soul, the first soul being absorbed by the Boora, or deity, the second is reborn into succeeding generations, the third goes out in dreams, and the fourth dies with the body.‡

Plato located in the human body three souls, the rational and immortal soul occupying the head, the lower souls occupying respectively the region near the heart and the abdominal region below the diaphram, the latter subject to and connected with the higher by being fastened to the spinal marrow or cord. Of these lower souls, the thoracic was the seat of energy and anger, while to the abdominal soul belonged the appetites, the desires, and the greed of gain.# Aristotle divided the soul into the vegetative, the perceptive, the locomotive, the impulsive, and the noetic, all but the latter being shared with animals, while the *nous* was divine, perhaps pre-existent and imperishable.‖ Among the Romans the question of the plural soul is open to discussion. Ovid says: "The shades flit round the tomb; the underworld receives the image; the spirit seeks the stars" (*Tumulum circumvolat umbra; orcus habet manes; spiritus astra petit*). In his "Tristia"^ he complains that, while his immortal spirit soars aloft into the vacant air, his shade will be wandering amid Sarmatian ghosts. Hardonin ◊ says that the Romans made a distinction between the souls of the dead and their shades, *umbræ*. The former were supposed to remain on earth, while the latter were removed either to Elysium or Tartarus, according to the character or actions of the deceased. That the idea of a triple soul lingered in England we know from Sir Toby Belch, in Shakespeare's "Twelfth Night," asking, "Shall we rouse the night-owl with a catch that will draw three souls out of one weaver?" Nares ‡ says that the peripatetic philosophy, which governed the schools in the time of the old English dramatists, assigned to every man three souls—the vegetative, the animal, and the rational. In his quaint "Letters," ↕ Howell tells us that the embryon is animated with three souls:

* Du Bose, "Dragon, Image, and Demon," p. 81; Williams, "The Middle Kingdom," vol. ii, p. 243.

† Farrar, *loc. cit.*

‡ McPherson, "India," p. 91.

\# Plato, "Timæus"; Grote's "Plato," vol. iii, p. 271, 272; Bain, "Senses and Intellect," p. 613.

‖ Cf. "De Gen. et Cor.," vol. ii, p. 3; "De Anima," vol. iii, p. 5.

^ Vol. iii, p. 3.

◊ Pliny, "Natural History," vol. vii, p. 57, note.

‡ "Glossary," vol. ii, p. 817.

↕ I., vol. iii, p. 36.

with that of plants, called the vegetable soul; then with the sensitive, which all brute animals have; and, lastly, the rational soul is infused; and these three in man, he adds, are like Trigonus in Tetragono.

The Iroquois and Algonquins believed that the soul which gave bodily life was of a vegetative character, and remained with the corpse after death until it was released by being reborn into another body; while the ethereal soul, which roamed at will while the body was asleep or in a trance, after death departed directly to the land of spirits.* Infants were buried by the sides of paths, that their vegetative souls might enter into the body of some mother, and their rebirth thus be hastened.† Among the Tucullus the medicine-man placed his hands over the breast of the dying, and then, holding them over the head of a relative, blew through the expanded fingers, in order that the next child born to him might be the representative of the departed.‡ Certain tribes on the Pacific coast believed that one of the souls had its dwelling in the bones, and, if these were planted, they would germinate like seed, and produce human beings.# The Choctaws believe that every man has an outside shadow, *shilombish*, and an inside shadow, *shilup*, both of which survived his body.‖ The Sioux believed in three souls, one of which went to the cold world, another to the warm world, while the third remained and watched over the body.△ Mrs. Eastman ◊ tells us that the Dakotas extended the number of souls to four, one of which wanders through the world, another hovers around the village where its possessor lived, the third stays by the grave, and the fourth goes to heaven. With certain Greenlanders one soul took the form of a shadow, the other that of the breath. ‡ The Feejeeans distinguished between a man's dark spirit or shadow, which goes down to hades, and his light spirit, the one that is reflected in water or a mirror, and which remains when he dies. ↕ The Malagasy say that the *saina*, or mind, vanishes at death; the *aina*, or life, becomes mere air; while the *matoatoa*, or ghost, hovers around the tomb. ‡

* "Rel. des Jesuits," 1636, p. 104.

† *Ibid.*, 1635, p. 130.

‡ Waitz, "Anthropology," vol. iii, p. 95.

\# Bancroft, "Native Races of the Pacific Coast," vol. iii, p. 514.

‖ Brinton, "Myths of the New World," p. 251.

△ "Hist. Coll. Louisiana," vol. iii, p. 26.

◊ "Legends of the Sioux," p. 129.

‡ Tylor, "Primitive Culture," vol. i, p. 432; Spencer, "Principles of Sociology," vol. i, p. 191.

↕ Williams, "Fiji and the Fijians," vol. i, p. 241.

‡ Ellis, "Madagascar," vol. i, 393.

THE HISTORY OF A DOCTRINE.*

By Prof. S. P. LANGLEY.

I.

IN these days, when a man can take but a very little portion of knowledge to be his province, it has become customary that your president's address shall deal with some limited topic, with which his own labors have made him familiar; and accordingly I have selected as my theme the history of our present views about radiant energy, not only because of the intrinsic importance of the subject, but because the study of this energy in the form of radiant heat is one to which I have given special attention.

Just as the observing youth, who leaves his own household to look abroad for himself, comes back with the report that the world, after all, is very like his own family, so may the specialist, when he looks out from his own department, be surprised to find that, after all, the history of the narrowest specialty is amazingly like that of scientific doctrine in general, and contains the same lessons for us. To find some of the most useful ones, it is important, however, to look with our own eyes at the very words of the masters themselves, and to take down the dusty copy of Newton, or Boyle, or Leslie, instead of a modern abstract; for, strange as it may seem, there is something of great moment in the original that has never yet been incorporated into any encyclopædia, something really essential in the words of the man himself which has not been indexed in any text-book, and never will be.

It is not for us, then, here to-day, to try—

"How index-learning turns no student pale,
Yet holds the eel of science by the tail";

but, on the contrary, to remark that from this index-learning, from these histories of science and summaries of its progress, we are apt to get wrong ideas of the very conditions on which this progress depends. We often hear it, for instance, likened to the march of an army toward some definite end; but this, it has seemed to me, is not the way science usually does move, but only the way it seems to move in the retrospective view of the compiler, who probably knows almost nothing of the real confusion, diversity, and retrograde motion of the individuals comprising the body, and only shows us such parts of it as he, looking backward from his present standpoint, now sees to have been in the right direction.

I believe this comparison of the progress of science to that of

* President's address before the American Association for the Advancement of Science, at Cleveland, Ohio, August 15, 1888. Reprinted from "Science."

the army which obeys an impulse from one head has more error than truth in it; and, though all similes are more or less misleading, I would almost prefer to ask you to think rather of a moving crowd, where the direction of the whole comes somehow from the independent impulses of its individual members, not wholly unlike a pack of hounds, which, in the long run, perhaps catches its game, but where, nevertheless, when at fault, each individual goes his own way by scent, not by sight, some running back and some forward; where the louder-voiced bring many to follow them, nearly as often in a wrong path as in a right one; where the entire pack even has been known to move off bodily on a false scent; for this, if a less dignified illustration, would be one which had the merit of having a considerable truth in it, but one left out of sight by the writers of books.

At any rate, the actual movement has been tortuous, or often even retrograde, to a degree of which you will get no idea from the account in the text-book or encyclopædia, where, in the main, only the resultant of all these vacillating motions is given. With rare exceptions, the backward steps—that is, the errors and mistakes, which count in reality for nearly half, and sometimes for more than half the whole—are left out of scientific history; and the reader, while he knows that mistakes have been made, has no just idea how intimately error and truth are mingled in a sort of chemical union, even in the work of the great discoverers, and how it is the test of time chiefly which enables us to say which is progress when the man himself could not. If this be a truism, it is one which is often forgotten, and which we shall do well to here keep before us.

This is not the occasion to review the vague speculations of the ancient natural philosophers from Aristotle to Zeno, or to give the opinion of the school-men on our subject. We take it up with the immediate predecessors of Newton, among whom we may have been prepared to expect some obscure recognition of heat as a mode of motion, but where it has been, to me at least, surprising, on consulting their original works, to find how general and how clear an anticipation of our modern doctrine may be fairly said to exist. Whether this early recognition of the atomic and vibratory theories be a legacy from the Lucretian philosophy, it is not necessary to here consider. The interesting fact, however it came about, is the extent to which seventeenth-century thought is found to be occupied with views which we are apt to think very recent.

Descartes, in 1664, commences his "Le Monde" by a treatise on the propagation of light, and what we should now call radiant heat, by vibrations, and further associates this view of heat as motion with the distinct additional conception that in the cause of light and radiant heat we may expect to find something quite different from the sense of vision or of warmth; and he expresses himself with the aid of the same simile of sound employed by Draper over two hundred years later. The writings of Boyle on the mechanical production of heat contain illustrations (like that of the hammer driving the nail, which grows hot in proportion as its bodily motion is arrested) which show a singularly complete apprehension of views we are apt to think we have made our own; and it seems to me that any one who consults the originals will admit that, though its full consequences have not been wrought out till our own time, yet the fundamental idea of heat as a mode of motion is so far from being a modern one, that it was announced in varying forms by Newton's immediate predecessors, by Descartes, by Bacon, by Hobbes, and in particular by Boyle, while Hooke and Huygens merely continue their work, as at first does Newton himself.

If, however, Newton found the doctrine of vibrations already, so to speak, "in the air," we must, while recognizing that in the history of thought the new always has its root in the old, and that it is not given even to a Newton to create an absolutely new light, still admit that the full dawn of our subject properly begins with him, and admit, too, that it is a bright one, when we read in the "Optics" such passages as these: "Do not all fixed bodies, when heated beyond a certain degree, emit light and shine, and is not this emission performed by the vibrating motions of their parts?" And again: "Do not several sorts of rays make vibrations of several bignesses?" And still again: "Is not the heat conveyed by the vibrations of a much subtler medium than air?"

Here is the undulatory theory; here is the connection of the ethereal vibrations with those of the material solid; here is "heat as a mode of motion"; here is the identity of radiant heat and light; here is the idea of wave-lengths. What a step forward this first one is! And the second?—the second is, as we now know, backward. The second is the rejection of this, and the adoption of the corpuscular hypothesis, with which alone the name of Newton (a father of the undulatory theory) is, in the minds of most, associated to-day.

Do not let us forget, however, that it was on the balancing of arguments from the facts then known that he decided, and that perhaps it was rather an evidence of his superiority to Huygens, that apprehending before the latter, and equally clearly, the undulatory theory, he recognized also more clearly that this theory, as then understood, failed utterly to account for several of the most important phenomena. With an equally judicial mind, Huygens would perhaps have decided so too, in the face of difficulties, all of which have not been cleared up even to-day.

These two great men, then, each looked around in the then darkness as far as his light carried him. All beyond that was chance to each; and Fate willed that Newton, whose light shone further than his rival's, found it extend just far enough to show the entrance to the wrong way. He reaches the conclusion that we all know; and with the result on other men's thought that, light being conceded to be material, heat, if affiliated to light, must be regarded as material too, for we may see this strange conclusion drawn from experiments of Herschel a century later.

It would seem that the result of this unhappy corpuscular theory was more far-reaching than we commonly suppose, and that it is hardly too much to say that the whole promising movement of that age toward the true doctrine of radiant energy is not only arrested by it, but turned the other way; so that in this respect the philosophy of fifty years later is actually further from the truth than that of Newton's predecessors.

The immense repute of Newton as a leader, on the whole so rightly earned, here leads astray others than his conscious disciples, and, it seems to me, affects men's opinions on topics which appear at first far removed from those he discussed. The adoption of phlogiston was, as we may reasonably infer, facilitated by it, and remotely Newton is, perhaps, also responsible in part for the doctrine of caloric a hundred years later. After him, at any rate, there is a great backward movement. We have a distinct retrogression from the ideas of Bacon and Hobbes and Boyle. Night settles in again on our subject almost as thick as in the days of the school-men, and there seems to be hardly an important contribution to our knowledge, in the first part of the eighteenth century, due to a physicist.

"Physics, beware of metaphysics," said Newton—words which physicists are apt so exclusively to quote, that it seems only due to candor to observe that the most important step, perhaps, in the fifty years which followed the "Optics," came from Berkeley, who, reasoning as a metaphysician, gave us during Newton's lifetime a conception wonderfully in advance of his age. Yet the "New Theory of Vision" was generally viewed by contemporary philosophers as only an amusing paradox, while "coxcombs vanquish[ed] Berkeley with a grin"; and this contribution to science —an exceptional if not a unique instance of a great physical generalization reached by *a priori* reasoning—though published in 1709, remains in advance of the popular knowledge even in these closing years of the nineteenth century.

In the mean time a new error had risen among men—a new truth, as it seemed to them, and a thing destined to have a strong reflex action on the doctrine of radiant energy. It began with the generalization of a large class of phenomena (which we now associate with the action of oxygen, then of course unknown)—a generalization useful in itself, and accompanied by an explanation which was not in its origin objectionable. Let us consider, in illustration, any familiar instance of oxidation, and try to look first for what was reasonable in the eighteenth-century views of the cause of such phenomena. A piece of dry wood has in it the power of giving out heat and light when set on fire; but after it is consumed there is left of it only inert ashes, which can give neither. Something, then, has left the wood in the process of becoming ashes; virtue has gone out of it, or, as we should say, its potential energy has gone.

This is, so far, an important observation, extending over a wide range of phenomena, and, if it had presented itself to the predecessors of Newton, it would probably have been allied to the vibratory theories, and become proportionately fruitful. But to his disciples, and to chemists and others who, without being perhaps disciples, were, like all then, more or less consciously influenced by the materiality of the corpuscular theory, it appeared that this also was a material emanation, that this energy was an actual ingredient of the wood—a crudeness of conception which seems most strange to us, but it is not, perhaps, unaccountable in view of the then current thought.

I have said that the progress of science is not so much that of an army as of a crowd of searchers, and that a call in a false direction may be responded to, not by one only, but by the whole body. In illustration, observe that during the greater part of the entire eighteenth century this doctrine was adopted by almost every chemist and by most physicists. It had quite as general an acceptance among scientific men then as the kinetic theory of gases, for instance, has now, and, as far as time is any test of truth, it was tested more severely than the kinetic theory has yet been; for it was not only the lamp and guide of chemists, and, to a great extent, of physicists also, but it remained the time-honored and highest generalization of chemico-physical science for over half a century, and it was accepted not so much as a conditional hypothesis as a final guide and a conquest for truth which should endure always. And now where is it? Dissipated so utterly from men's minds that, to the unprofessional part of even an educated audience like this, "phlogiston," once a name to conjure with, has become an unmeaning sound.

There is no need to insist on the application of the obvious moral to hypotheses of our own day. I have tried to recall for a moment all that "phlogiston" meant a little more than a hundred years ago, partly because it seems to me that, though a chemical conception, physics is not wholly blameless for it, but chiefly because before it quitted the world it appears to have returned to physics the wrong in a multiplied form by generating an offspring especially inimical to true ideas about radiant heat, and which is represented by a yet familiar term. I mean "caloric."

This word is still used loosely as a synonym for heat, but has quite ceased to be the very definite and technical term it once was. To me it has been new to find that this so familiar word "caloric," so far as my limited search has gone, was apparently coined only toward the last quarter of the last century. It is not to be found in the earliest edition of Johnson's Dictionary, and, as far as I can learn, appears first in the corresponding French form in the works of Fourcroy. It expressed an idea which was the natural sequence of the phlogiston theory, and which is another illustration that the evil which such theories do lives after them.

"Caloric" first seemingly appears, then, as a new word coined by the French chemists, and meant originally to signify the unknown cause of the sensation heat, without any implication as to its nature. But words, we know, though but wise men's counters, are the money of fools; and this one very soon came to commit its users to an idea which was more likely to have had its origin in the mind of a chemist at that time than of any other—the idea of the cause of heat as a material ingredient of the hot body; something not, it is true, having weight, but which it would have been only a slight extension of the conception to think might one day be isolated by a higher chemical art, and exhibited in a tangible form.

We may desire to recognize the perverted truth which usually underlies error, and gives it currency, and be willing to believe that even "caloric" may have had some justification for its existence; but this error certainly seems to have been almost altogether pernicious for nearly the next eighty years, and down even to our own time. With this conception as a guide to the philosophers of the last years of the eighteenth century, it is not, at any rate, surprising if we find that at the end of a hundred years from Newton the crowd seems to be still going constantly further and further away from its true goal.

Although Provost gave us his most material contribution about 1790, we have, it seems to me, on the whole, little to interest us during that barren time in the history of radiant energy called the eighteenth century—a century whose latter years are given up, till near its very close, to bad *a priori* theories in our subject, except in the work of two Americans; for in the general dearth, at this time, of experiments in radiant heat, it is a pleasure to fancy Benjamin Franklin sitting down before the fire, with a white stocking on one leg and a black one on the other, to see which leg would burn first, and to recall again how Benjamin

Thompson (Count Rumford) not only weighed "caloric" literally in the balance and found it wanting, but made that memorable experiment in the Munich foundries which showed that heat was perpetually and without limit created from motion.

It was in the last years of the century, too, that he provided for the medal called by his name, and which, though to be given for researches in heat and light, has, I believe, been allotted in nearly every instance to men who, like Leslie, Malus, Davy, Brewster, Fresnel, Melloni, Faraday, Arago, Stokes, Maxwell, and Tyndall, have contributed toward the subject of radiant energy in particular.

We observe that till Rumford's time the scientific literature of the century scarcely considers the idea even of radiant heat, still less of radiant energy; so that we have been obliged here to discuss the views of its physicists about heat in general, heat and light in most eighteenth-century minds being distinct entities. We must remember, then, to his greater honor, that the idea of radiant heat as a separate study has before Rumford scarcely an existence; all the ways for pilgrims to this special shrine of truth being barred, like those in Bunyan's allegory, by two unfriendly monsters who are called Phlogiston and Caloric, so that there are few scientific pilgrims who do not pay them toll.

The doctrine of caloric is, however, even then recognized as a chemical hypothesis rather than one acceptable to physicists, some of whom still stand out for vibratory theories even through the darkest years of the century; and, further, we may find, on strict search, that the old idea of heat as a mode of motion has not so utterly died that it does not appear here and there during the last century, not only among philosophers, but even in a popular form.

In an old English translation of Father Regnault's compilation on physics, dated about 1730, I find the most explicit statement of the doctrine of heat as a mode of motion. Here heat is defined (with the aid of a simile due, I believe, to Boyle) as "any Agitation whatever of the insensible parts. Thus a Nail which is drove into the Wood by the stroke of a Hammer does not appear to be hot, because its immediate parts have but one common Movement. But should the Nail cease to drive, it would acquire a sensible Heat, because its insensible Parts which receive the Motion of the Hammer now acquire an agitation every way rapid." We certainly must admit that the user of this illustration had just and clear ideas; and the interesting point here appears to be, that as Father Regnault's was not an original work, but a mere compendium or popular scientific treatise of the period, we see, if only from this instance, that the doctrine of heat as a mode of motion was not confined to the great men of an earlier or a later time, but formed a part of the common pabulum during the eighteenth century to an extent that has been singularly forgotten.

The last years of the eighteenth century were destined to see the most remarkable experiments in heat made in the whole of the hundred; for the memoir of Rumford appeared in the "Philosophical Transactions" for 1798; and in the very year 1800 appeared in the same place Sir William Herschel's paper, in which he describes how he placed a thermometer in successive colors of the solar spectrum, finding the heat increase progressively from the violet to the red, and increase yet more beyond the red where there was no color or light whatever; so that there are, he observes, invisible rays as well as visible. More than that, the first outnumber the second; and these dark rays are found in the very source and fount of light itself. These dark rays can also be obtained, he observes, from a candle or a piece of non-luminous hot iron, and, what is very significant, they are found to pass through glass, and to be refracted by it like luminous ones.

And now Herschel, searching for the final verity through a series of excellent experiments, asks a question which shows that he has truth, so to speak, in his hands—he asks himself the great question whether heat and light be occasioned by the same or different rays.

Remember the importance of this (which the querist himself fully recognized); remember that, after long hunting in the blindfold search, he has laid hands, as we now know, on Truth herself, and then see him—let go. He decides that heat and light are not occasioned by the same rays, and we seem to see the fugitive escape from his grasp, and not to be again fairly caught till the next generation. I hardly know more remarkable papers than these of Herschel's in the "Philosophical Transactions" for 1800, or anything more instructive in little men's successes than in this great man's failure, which came in the moment of success. I would strongly recommend the reading of these remarkable original memoirs to any physicist who knows them only at second hand.

One more significant lesson remains, in the effect of this on the minds of his contemporaries. Herschel's observation is to us almost a demonstration of the identity of radiant heat and light; but now, though the nineteenth century is opening, it is with the doctrine still in the minds of most physicists, and perhaps of all chemists, that heat is occasioned by a certain material fluid. Phlogiston is by this time dead or dying, but caloric is very much alive, and never more perniciously active than now, when, for instance, years after Herschel's observation, we find this cited as "demonstrating the existence of caloric," which was, it seems, the way it looked to a contemporary.

In the year 1804 appeared what should be a very notable book in the history of our subject, written by Sir John Leslie, whose name survives perhaps in the minds of many students chiefly in connection with the "cube," which is still called after him. Leslie, however, ought to be remembered as a man of original genius, worthy to be mentioned with Herschel and Melloni; and his, too, is one of the books which the student may be recommended to read, at least in part, in the original; not so much for the writer's instructive experiments (which will be found in our text-books) as for his most instructive mistakes, which the text-book will probably not mention.

He began by introducing the use of the simple instrument which bears his name, and a new and more delicate heat-measure (the differential thermometer); and with these, and concave reflectors of glass and metal, he commenced experiments in radiant heat, than which, he tells us, no part of physical science then appeared so dark, so dubious, and so neglected. It is interesting, and it marks the degree of neglect he alludes to, that his first discovery was that different substances have different radiating and absorbing powers. It gives us a vivid idea of the density of previous ignorance, that it was left to the present century to demonstrate this elementary fact, and that Leslie, in view of such discoveries, says, "I was transported at the prospect of a new world emerging to view."

Next he shows that the radiating and absorbing powers are proportional, next that cold as well as heat seems to be radiated, and next undertakes to see whether this radiant heat has any affinity to light. He then experiments in the ability of radiant heat to pass through a transparent glass, which transmits light freely, and thinks he finds that none does pass. Radiant heat with him seems to mean heat from non-luminous sources; and the ability or non-ability of this to pass through glass is to Leslie and his successors a most crucial test, and its failure to do so a proof that this heat is not affiliated to light.

Let us pause a moment here to reflect that we are apt to unconsciously assume, while judging from our own present standpoint where past error is so plain, that the false conclusion can only be chosen by an able, earnest, conscientious seeker, after a sort of struggle. Not so. Such a man is found welcoming the false with rapture as very Truth herself. "What, then," says Leslie, "is this calorific and frigorific fluid after which we are inquiring? It is not light, it has no relation to ether, it bears no analogy to the fluids, real or imaginary, of magnetism and electricity. But why have recourse to invisible agents? *Quod petis, hic est.* It is merely the ambient AIR."

The capitals are Leslie's own, but ere we smile with superior knowledge let us put ourselves in his place, and then we may comprehend the exultation with which he announces the identity of radiant heat and common air, for he feels that he is beginning a daring revolt against the orthodox doctrine of caloric, and so he is.

[*To be continued.*]

INFANT MORTALITY AND THE ENVIRONMENT.

By J. M. FRENCH, M. D.

IT is a startling fact, which meets the student of vital statistics at the outset of his investigations, that from one third to one half of all persons born into the world die before reaching the age of five years. Or, to face the terrible reality from another point of view, so great are the dangers of infancy, that a child which has completed its fifth year actually has an expectation of life more than twelve years greater than it had at birth.

The exact proportion of deaths varies greatly in different countries and localities, at different times and under different circumstances. Statistics are of value only in showing average results. In Norway, for example, the proportion dying under five is stated by Dr. Farr to be 204·5 per 1,000 born; while in England it is 338 per 1,000, and in Italy 567 per 1,000. In fifty-one so-called "healthy districts" of England and Wales, according to the same authority, the mortality under five is 175 per 1,000 born, while in the Liverpool district, representing the most unfavorable sanitary conditions, it is 460 per 1,000.

In the different parts of our own country, we find nearly as great a variety as on the continent of Europe. Even in the same latitude, the proportion varies greatly, according as city or country districts are considered. In the State of Vermont, which contains no large cities, and represents essentially a rural population, the number of deaths under five, for the year 1883, was 23·8 per cent of the whole number of deaths; in the State of Massachusetts, which embraces several large cities within its limits, for the twelve years ending in 1884, it was 34·74 per cent; and in the city of New York alone, for the seven years ending in 1873, it was exactly 50 per cent of the entire mortality.

The younger the child, the larger is the death-rate. According to Dr. Jacobi, more than half of those who die under five years of age die in the first year. Dr. Curtiss states that, in all the great cities of North America, out of every one hundred live-born children, about twenty-five die before the end of the first year, and from forty to fifty before the close of the fifth year.

Death-rates like these—and the figures might be multiplied indefinitely—challenge our earnest attention and demand our careful consideration. Let us first inquire what are the diseases which are the immediate cause of the great bulk of infant mortality. These may be grouped in four main classes, namely:

(1) *The acute infectious zymotics*, of which the chief are measles, scarlet fever, small-pox, diphtheria, and whooping-cough. These are collectively responsible for from fifteen to twenty per cent of the deaths under five.

(2) *The acute lung-diseases*, chiefly bronchitis and pneumonia, which together cause from ten to fifteen per cent of the deaths under five. In America, more than twice as many deaths occur from pneumonia as from bronchitis, while in England nearly the reverse is true.

(3) *Tubercular and constitutional diseases*, such as consumption, scrofula, meningitis, and hydrocephalus, which are responsible for from ten to fifteen per cent of the entire infant mortality.

(4) *The diarrhœal diseases*, comprising infantile diarrhœa, cholera infantum, inflammation of the bowels, dysentery, and some others. These are the cause of at least one fourth of the entire infant mortality the world over; while in America cholera infantum alone is responsible for nearly or quite one fifth.

But the problem before us is not one which can be solved by a simple rehearsal of the names of diseases and the number of their victims. These only show the form and manner of death, while the ultimate causes lie far in the background.

The real questions at issue relate to those influences which are at work upon so large a proportion of infants and young children the world over, tending to break down in them the power of resisting disease, lessen their chances of a vigorous, healthy life, and render them unduly liable to go down to early graves. What is the nature of these influences? What circumstances tend to increase their activity? Under what conditions and to what extent may they be rendered inert, or their usual dire effects be avoided? By what means may an unfavorable environment be changed to a favorable one, and the vitality and longevity of the race be thereby increased?

In considering these questions, it must be remembered that the causes of infant mortality are also the causes of adult mortality, only in a less degree; and that the health of a delicate infant is the most sensitive measure which we possess of those influences which are deleterious to health, either in infancy or adult life.

The first of these deleterious influences in the order of time, and unquestionably also of importance, is *heredity*. A very large proportion of all children born into the world are either weaklings or invalids from the beginning. They are born wrong. They come from poor stock. The influences which determine their weakness to-day have been at work for ages upon ages. That was no sarcasm, but the plainest statement of scientific truth, on the part of Oliver Wendell Holmes, when, after declaring his conviction that every disease might be cured if taken in season, he added, significantly, that in some cases it would be necessary to begin a hundred years before the patient was born. This is a hard world, and no weakling ever has half a chance. "The survival of the fittest" is a merciful provision of nature. "The strongest live and the weakest die." A race of criminals, paupers, and idiots deteriorates with each successive generation, and goes down to speedy extinction. It is the robust, sturdy, clear-headed, strong-handed toiler of to-day, whose sons and daughters will inhabit homes of wealth and occupy positions of responsibility a few years hence.

The effects of unfavorable heredity may be manifested in various ways. In the first place, the child may be born with the disease already developed. Examples of this class may be seen in hypertrophies, atrophies, and inflammations of various organs; in exudations, as hydrocephalus; in infantile syphilis; in new growths, such as nævus, tumors, and certain forms of cancer; in the pre-natal deposition of tubercles, parasites, and some inorganic products; in arrests of development, such as cleft-palate, hare-lip, spina bifida, and that defective closure of the heart which produces cyanosis; and in those unusual developments known as monstrosities. Secondly, the disease may be transmitted, although its manifestations are not developed at birth. This may be the case with some of the diseases already mentioned as also occurring in the first class, as well as with many others. Examples are seen in scrofula, cancer, consumption, epilepsy, rheumatism, gout, insanity, and the "specific" disease. Again, there may be no actual disease, but only a tendency to disease, in the shape of an inherited weakness of some special organ or in some particular direction. These tendencies render their possessors unduly liable to suffer from particular diseases, but do not make it necessary that they should do so, provided that their environment is favorable. Lastly, the faulty heredity may be manifest only in a general weakness of the whole system, a lack of vigor and vitality, which renders its possessor an easy victim to whatever malady may attack him. This is the cause of many of the deaths which are registered under the heads of infantile debility, diarrhœa, brain-disease, and other common affections of infancy.

To the actual diseases, special weaknesses, and unsound constitutions resulting from unfavorable heredity, add now the environment of *poverty*, with its usual accompaniments of ignorance, carelessness, and inefficiency on the part of the parents, resulting for both parents and children in privation of food, clothing, shelter, and fuel, and we begin to have some faint conception of the perils which surround infant-life in a large proportion of cases. Without adequate nourishment, and improperly cared for in every respect, life is one sharp struggle with want, and it is little wonder that want often gains the victory. In England, for the ten years ending with 1875, an average of eighty-two deaths annually was assigned to starvation alone. But privation and destitution exercise a controlling influence over the mortality of infancy under other names than this. What the form of death shall be is determined by various circumstances. It occurs largely from the diseases of denutrition and debility, rickets, scrofula, consumption, and other constitutional diseases.

Exposure to *cold and wet*, especially in the sharp vicissitudes of our winter climate, and more particularly when this is added to the causes already named, results in a largely increased prevalence of the acute lung-diseases. These are extremely fatal even in adults, and the mortality is proportionately large in children. Says Routh, in his work on "Infant Feeding": "Among the most pernicious influences among young children we may include cold. It is a household word among us, which takes its origin from the Registrar-General's returns, that a very cold week always increases the mortality of the very young and the very aged." The same statement is true in America, though it may be in a somewhat less degree, owing to the fact that our houses are better provided against extreme cold than are those of the English. Throughout England, one sixth of all deaths from lung-diseases occur under five. In London, forty-four per cent of the deaths from pneumonia and bronchitis take place under that age. In Massachusetts, the proportion of deaths from pneumonia under five is thirty-four per cent. These deaths occur largely in the inclement portions of the year. In England, both bronchitis and pneumonia attain their maximum in the first quarter of the year, decline during the second quarter, reach their minimum during the third, and begin to increase during the fourth. In Michigan, Dr. H. B. Baker has shown that the greatest prevalence of the acute lung-diseases is in February, and the least in August. In Massachusetts, March has the largest number of deaths, and August the least.

Four distinct but closely related causes combine to produce the diarrhœal diseases, which result in one fourth of the entire mortality under five. These are heat, improper feeding, filth, and overcrowding. The influence of *heat* is seen in the facts that, in our climate, the overwhelming majority of cases in these diseases occur during the hottest months of the year; that their prevalence is greater in the southern portions of the temperate zone than in the northern, and in unusually hot summers than in those whose average temperature is less; and, in general, that the number of deaths from these causes is directly proportional to the elevation of temperature, especially if it be long continued. Thus, of 3,216 deaths from the diarrhœal diseases in Vermont, New Hampshire, Massachusetts, Rhode Island, and Connecticut in 1883, 2,745, or eighty-five per cent, occurred during the months of July, August, and September. The same States showed an increased mortality from these causes during the unusually hot summers of 1880 and 1882. In the city of Boston, for the nine years from 1867 to 1875 inclusive, the mean temperature of the months of July and August varied from 68·6° in 1874 to 72·3° in 1870, and averaged 70·5°. The highest death-rate was in 1872, when the mean for the two months was 71·9°, and for the hottest single month was 73·1°; and the lowest was in 1867, with a mean for the two months of 69·8°, and for the hottest month of 70·4°. In New York, during the month of July, 1872, the mean temperature was 79·57°, or 3·43° higher than the average for the ten previous years. As a result, the mortality for the quarter was the highest ever known in the city, and that notwithstanding that the other two months were not unusually hot.

It must be stated that, fatal as is the effect of heat upon children under five, the proportionate mortality is still greater when the investigation is limited to infants under one year of age. Dr. Blackader says that a very hot summer month will triple or even quadruple the mortality of infants under one year, though that of children from one to five is barely doubled. During the year 1872, in New York, nearly sixty per cent of all deaths were under one year of age, and more than forty per cent took place in the summer quarter.

The effects of *improper feeding* are seen in the fact that, whether in city or country, in hot summers or cool, only a very small proportion of deaths from infantile diarrhœa occur among infants who are properly nursed upon the milk of a healthy mother—which must be considered the only natural and proper method of feeding young infants.

Sir Hans Sloane showed years ago that the mortality of those properly nursed upon breast-milk was to that of those who were bottle-fed as 19·2 to 53·9 per cent. Dr. J. Wilmarth reports that in a country practice in Massachusetts, out of one hundred and one children nursed wholly, or nursed and fed with nursing after a few months to weaning-time, and who were under his observation for a series of years, there were twelve deaths from various causes, none of them from cholera infantum; while among nineteen children artificially fed, there were during the same time eight deaths, six of them from cholera infantum. Says Messener: "Cholera infantum attacks only those children who have been raised without breast-milk, those who have been weaned too early or too hastily, or those to whom, on account of the failure of the mother's milk, other foods have been injudiciously administered. Under other circumstances than these, children enjoy a complete immunity."

The artificial feeding of infants often results from physical inability on the part of the mother to nurse them, and this inability in turn is the result of defective heredity. "The mother makes the child," and the mother's weakness ofttimes results in the death of the child, or even of the children's children.

When we turn to consider the merits of the different forms of artificial feeding, we realize the intimate relation of improper feeding to the next cause, namely, *filth*. Cow's milk, the most common and generally advisable substitute for mother's milk, when exposed to the air at a summer temperature, soon ferments and develops a peculiar poison known as *tyrotoxicon*, which is a most potent factor in the causation of cholera infantum. It is also, says Prof. Lister, "a pabulum for all kinds of organisms; nearly all varieties of bacteria will live in it." In addition to this, it often absorbs and becomes the carrier of various other forms of filth, both organic and inorganic, all of which either directly or indirectly increase the tendency to disease. These evil results may be avoided, in a large measure at least, by the modern process of sterilization of milk, whereby existing germs are destroyed, air excluded, and fermentation prevented.

But filth may be introduced in other ways than in milk or food of any kind; and, however introduced, its effects are always disastrous. Says Mr. Simon: "Nothing in medicine is more certain than the general meaning of high diarrhœal rates. The mucous membrane of the intestinal canal is the excreting surface to which nature directs all the accidental putridities which enter us. Whether they have been breathed, or drunk, or eaten, it is there that they settle and act. As wine gets into the head, so these agents get into the blood. There, as their universal result, they tend to produce diarrhœa."

In August, 1883, the health-officer of New Haven, Conn., in a paper entitled "A Practical Argument for Sewers," reported the following, which well illustrates the evil effects of impure air: "There were forty-three deaths in New Haven from infantile diarrhœa in July. The forty-three deaths occurred in thirty-two different streets and in thirty-eight different houses. But the most remarkable fact is that thirty-four of the forty-three victims were living upon streets in which there is no public sewer, and in houses about which are still tolerated those beastly abominations called cess-pools and privy-vaults. In most of the nine cases where the houses had sewer connections, they were only for kitchen and laundry purposes, and the stinking vault still maintains its position in the back yard. Observe this fact also: a considerable majority of the population of New Haven resides upon the sewered streets, and yet only nine out of forty-three deaths from a disease which is chiefly caused by foul air occur among the majority; while thirty-four of the forty-three are among the minority, who reside in dwellings surrounded by the fragrant companionship of time-honored filth-pits. Any person can draw intelligent inference from the above plain facts."

The remaining important factor in the production of infantile diarrhœa is *overcrowding*. This, indeed, is but the occasion of one of the most dangerous forms of filth, in the shape of air deprived of its vitalizing qualities, and charged with impurities derived from the breath and bodies of men and animals, which is sometimes known as "crowd-poison." "It is this air," says Dr. Richardson, "in our overcrowded towns and cities, where there is no vegetation to revivify it, which we distinguish as something so different from the fresh country air that streams over meadow and forest. It is the breathing of this air that makes the child of the town so pale and lax and feeble, as compared with the child of the country. It is this air that renders the atmosphere of the crowded hospital so deficient in sustaining power. It is this air that gives to many of our public institutions, in which large masses of our poorer, ill-clad, uncleansed masses are herded together, that 'poor-smell,' as it is called, which is so depressing both to the senses and to the animal power."

Cholera infantum is well known to be almost exclusively a disease of cities, and absolutely so in its epidemic form. The city of Manchester, N. H., contains only about one tenth of the population of the State, yet in 1883 it furnished nearly one half of the whole number of deaths from this disease; while in 1885, the three cities of Dover, Portsmouth, and Manchester, together containing less than one sixth of the whole population, reported considerably more than one half of the entire mortality from cholera infantum. The State of Massachusetts contains eighteen cities and towns of more than fifteen thousand inhabitants, while Vermont has none. The mortality from cholera infantum in 1883 was 3·49 per 10,000 in Vermont, and 9·53 per 10,000 in Massachusetts.

According to Dr. Farr, the mortality of districts increases with the density of their population; not, however, in the direct proportion of their densities, but as the sixth root of their densities. But while the total mortality increases in this proportion, the mortality under five increases in a much greater ratio. Thus, with a density of 166 to a square mile, the death-rate at all ages is 16·94 per 1,000, while of those under five it is 37·8 per 1,000. This ratio increases gradually and with considerable regularity with the density of the population in the districts considered, until with a population of 65,823 to a square mile, the death-rate for all ages reaches 38·67 per 1,000, and for those under five, 139·52 per 1,000—that is, while the total death-rate is increased a little more than twofold, that under five was nearly quadrupled.

Another fruitful cause of death, and one which especially helps to swell the mortality of infancy, is *contagion*, including in that term all those influences by which disease is communicated from one individual to another, either by direct contact or through the atmosphere. This is the prime cause of the large class of zymotic or germ diseases, which in their various forms carry off nearly one third of all children dying under the age of five years. In general terms it may be stated that, while contagion is the direct cause of these diseases, yet their prevalence and fatality are in inverse proportion to the general observance of the laws of public sanitation and private hygiene.

The depressing influences of extreme poverty, filth in all its forms, and the overcrowding of large cities, are great promoters of contagion, resulting in epidemics, plagues, and pestilences; while strict cleanliness, fresh air, pure water, and hygienic living, tend greatly to restrict its spread and prevent these results. Temperature, also, has much to do with the prevalence of zymotic diseases, some of which require a certain high degree of average temperature, while others thrive best in cold weather. Extreme degrees of heat and cold (boiling and freezing) destroy the life of most germs, but not of all. Thus, the first sharp frosts of autumn cut short the progress of yellow fever, while diphtheria is somewhat more prevalent in winter than in summer. The strict isolation of the sick, and careful disinfection of their surroundings, are also essential to the limitation or prevention of contagious diseases.

The death-rate among infants and young children is especially influenced by the five principal acute contagious or infectious diseases—namely, measles, scarlet fever, small-pox, diphtheria, and whooping-cough. According to English life-tables, these five diseases were the cause of 18·8 per cent of the entire mortality under five for the ten years from 1860 to 1870, while the average age of all persons dying from whooping-cough was 1·8 years, from measles 2·7 years, from diphtheria and scarlet fever 5·8 years, and from small-pox 11·9 years.

This latter disease, which was formerly by far the most fatal of the class, has of late years been shorn of its terrors by the beneficent discovery of Jenner. Thus, during the sixteenth and seventeenth centuries, it is estimated that from seven to twelve per cent of all deaths were caused by small-pox; while since the general introduction of vaccination the proportion has been reduced to less than one per cent.

The next most dreaded and at present the most fatal of these diseases is scarlet fever. In England, during the period already named, 6·7 per cent of all deaths under five were due to this cause; while an analysis of the registration reports of Massachusetts shows that two thirds of the deaths from this cause occur under five years of age.

Diphtheria is especially a filth-disease as well as a contagious disease; while the prevalence of each member of the class varies greatly in different localities and different years, being largely dependent upon certain unknown epidemic influences, which as yet have not been brought under the control of man.

THE ORIGIN OF FOREST-GROUPINGS.

By the MARQUIS DE SAPORTA.

THE organic relations or homologies of structure, showing connections of different beings with one another, which, in ignorance of their real bearing, were formerly made useful only for the classification of animals and plants into natural groups, have acquired a new significance since the doctrine of evolution has been brought to bear upon questions of origin and of the progress through time and space of living beings and their relations with those beings whose former existence is revealed by paleontology. The question whether there are evidences of affiliation of the former by the latter, of a direct relationship, has received attention from students; and, as one of the attempts to solve it, we may mention M. Gaudry's essay on "The Links in the Animal World," in which the development of the mammalia through geological times is investigated on the basis of the osseous frame. A difficulty that has never been surmounted besetting the study of the terrestrial mammalia with aërial respiration, arises out of their power of changing their place, which, while it is limited by geographical restrictions in the case of quadrupeds, is complete with birds. It is easy to conceive that overlappings and general irregularities have time and again been introduced into the combinations of groups of animals which any given country has successively contained. By that fact alone, the new-comers of each period, at points where we have not been able to observe their ancestors in the country of their origin, have an air of having risen suddenly and been preceded by nothing.

This is not so much the case in the vegetable kingdom, and is least so with its most eminent representative, the tree, particularly the forest tree or the tree that has become social. It is true that while we sometimes possess of fossil animals entire skeletons, and nearly always parts on which we can justly base a classification, we ordinarily get of the ancient trees only isolated specimens of leaves, or more rarely of fruits and seeds. We, nevertheless, generally succeed in determining these relics, and, by comparing them with analogous living ones, in forming conclusions, the probability of which carries conviction. Thus, with the aid of the data furnished by stratigraphy, we can not only reconstitute the forests of former days, but can also arrange them chronologically, grasp their mutual relations, establish their filiations, and finally explain how they have in the past been displaced and renewed.

It is necessary to take account of the peculiarity that trees are enrooted or fixed in the soil, so that only their seeds can leave them and be carried away, but never to a very great distance. This fixity is certainly one of the causes of the regularity and relative slowness of the modifications to which arborescent vegetation has been subjected in the periods anterior to ours. The new-comers of each region can never have rapidly traversed distances. It has been rather by slow steps, and by the aid of at first partial introductions, that the flora of all the epochs has been transformed. Instead of leaps, we meet with modifications aided by time, which were worked out through a long duration before becoming definitive. An attentive examination of the vegetable impressions collected over many successive levels and at points distributed along the course formerly followed by the vegetation, and marking its advance, should therefore enable us to recover the partial terms of the presumed filiation of the types whose origin we are investigating.

One phenomenon has been remarked in intimate relation with this gradual and successive substitution of plants; it is the cooling of the globe, operating insensibly, but subject to a general movement, the progress of which, although extremely slow, has never been arrested. Plants have pursued their migrations under the rule of this phenomenon, moving toward the south and gradually abandoning the north, beginning with the extreme north, or the immediate environs of the pole. The discovery of numerous vegetable fossils at different points in the arctic regions, in Spitzbergen, Greenland, Grinnell Land, etc., has been sufficient to give rise to terms of comparison and demonstrate what was the character of fossil vegetation when that of Europe more or less resembled the present vegetation of countries near the tropics. Hence it has been possible to establish with fair probability not only the general march but also the filiation of a number of plants; and it has been ascertained that the direct ancestors of part of our trees originally inhabited the interior of the polar circle, while many others, confined now to southern countries, once had European predecessors. "The forest" may be defined as an association of trees freely grouped over a space; or, as the vegetable kingdom delivered to its own forces and meeting conditions favorable to its becoming master of the soil and spreading its wealth over it. The "virgin" forest is the forest into which man has penetrated only in passing, or upon which he has never laid hand to attack or modify it. It is peculiarly the forest of hot countries, or of the intertropical zone, where everything concurs to stimulate luxuriance of the vegetable kingdom. Even in temperate climates, whose pretensions of this kind are modest, we have only to transport ourselves into some region where the native forest yet exists in all its primitive grandeur, to perceive at once the might and majesty of the vegetable kingdom thus abandoned to itself, and having uncontested possession of the territory. Forestal associations interpret the influence of the climate to which they are adapted. They change in aspect and composition according to the latitude, and present characteristic diversities combined in a determined and successive order as we advance from the neighborhood of the polar circle toward the south. In the review which we can make of them, they constantly present a double aspect, as they may be considered in themselves, or as with reference to their relations with the past, and their bonds of kindred with anterior vegetations. But, previous to placing ourselves at the latter point of view, we should glance at existing plants to determine the features of the order which now presides over their distribution.

The domain of the forest extends beyond the polar circle in Europe and Siberia, where it reaches and even passes a little above the seventieth degree. In America it retreats from that region about Labrador and Hudson Bay, the polar circle being hardly indented in the interval between Mackenzie River and Bering Strait. But in this domain, as in those that succeed it, an essential distinction should be made between the resinous forests, consisting almost exclusively of conifers, and those that are composed of "foliage-trees." In the north, the forests of resinous trees extend over great spaces. In central or more southerly regions, these forests prefer the mountainous masses. Besides the conifers, many foliage-trees—among them the birches, alders, aspens, willows, and mountain-ash—penetrate within the polar circle, and constitute a part of the arctic forests. South of the sixtieth degree in Europe, and of a lower latitude in America, there extends a richer assemblage of varieties, but insensibly connected with the preceding one. The birch, oak, elm, maples, ashes, and limes are its characteristic trees, while the foliage-trees and conifers of the preceding group are not excluded from it. The latter show a tendency to graduate themselves on the slopes as they ascend them, much as, in going from southern to northern countries, we pass through regions occupied by like series of vegetation. Pursuing our course from north to south, we find the beech giving place in lower latitudes to varieties of oak; and it is one of the effects of this movement that other oaks appear at first in scattered colonies, as does also the chestnut, which, aside from its requirements as to the composition of the soil, seems to find, especially in southern Europe, the conditions normal to its forest development. The association of foliage-trees, whose outline is thus sketched, which would cover central Europe with a continuous forest if the continent had not been taken possession of by cultivation, is found on the southern slopes of the great mountain-ranges, only under specially favorable conditions of altitude and moisture. Its principal characteristics, besides the particular grouping of species, result from the winter caducity of the leaves, to the law of which the holly, the box, and the ivy—types also belonging to the next southern or Mediterranean group—are almost the only exceptions.

The Mediterranean group touches abruptly on the preceding one, and derives its name from the Mediterranean Sea, of which it occupies the whole periphery. In all the regions within this perimeter a similar forest flora covers with the same species a soil generally hilly, under a climate dry and warm, while subject to violent contrasts. The evergreen oaks, other oaks with semi-persistent foliage, the laurel, olive, pomegranate, terebinths, some of the maples, the oleander, and the carob; numerous shrubs with persistent leaves—laurestinuses, arbutuses, mock-privets, daphnes, heaths, cistuses, etc.—contribute to the constitution of this assemblage, which is all the more striking because an astonishing richness of characteristic details is concealed in it under an apparent uniformity. A more careful examination of the elements of which this flora is composed is demanded if we undertake to seek their origin. Besides the foliage-trees, the group includes conifers which are peculiar to it. The pines alone cover a large extent, one of them, the Aleppo pine, being very generally diffused, while a number of other species have each their determined station and place. The mountains in the interior of the region bear species that are special to them, and it is to such scattered islands of vegetation that we are indebted for such choice garden-plants as the spruces of Andalusia, Numidia, Mount Parnassus, Cephalonia, and Cilicia. In the same category are the cedars, which, with different names and varietal distinctions, people the ridges above a certain level of altitude of the Taurus, Lebanon, and Atlas. These are the mountaineer conifers, adapted to the Alpine stations of the Mediterranean region, where the altitude permits the beech, chestnut, maples, lindens, and birch to reappear and maintain themselves here and there in sporadic colonies.

Another distinct grouping of species in the bosom of this region is dependent on the nature of the soil. It includes the cork-oak, the chestnut, and the maritime pine, which are limited to the siliceous zone, and with them a whole train of plants and shrubs which are found with striking uniformity wherever the mineral composition of the soil is of similar character. So strict an adaptation, so absolute a selection, could not have been the work of a small number of centuries, but they may properly be attributed to causes that existed in a remote past.

To complete our review of the Mediterranean forest-grouping, we should consider, besides the dominant forms, some exceptionally sheltered parts of the regions, and other regions in which intermittent rigors of temperature have spared only the hardiest types. Three elements may be distinguished in the aggregate of about two hundred species included in the forestal vegetation of this region: First, the principal and characteristic element, in which plants with persistent leaves predominate, and which includes among its rarer types species in a declining condition, which are cantoned upon the best-sheltered or most southern points, and are transitional toward tropical types; next, the mountaineer element, to which altitude is favorable; and a third element, to which heat and moisture are agreeable. The last includes plants with deciduous leaves, which, while they can accommodate themselves to a cold climate, are better adapted to southern temperatures, and do not grow spontaneously in the central region; with which corresponds a group of trees—large, not very numerous, and usually monotypal—which deserves attention because of what it has been in the past, and which may be said to represent the southern prolongation of the central group, elbowing into the Mediterranean region. Its members, including the alder, the Eastern witch-elm, the hornbeam, the plane, the liquidambar, the fig, vine, some ashes, lindens, and walnut, are more in contrast with the mass of the Mediterranean plants than with the types equivalent in order that are domiciled farther north. It might be said of them that, while they are found associated with the former plants, they belong naturally to the category of the latter, as they would visibly had not the free extension of these to the southward been arrested. This view is confirmed by the examination of the forestal flora of a corresponding latitude in America. The absence on that continent of any vegetable domain equivalent to that of the Mediterranean disengages that element, and supplies, through the plane, the liquidambar, the persimmon, and American vines and walnuts direct from the ancient world, a parallelism or a repetition of forms which the study of paleontology helps to illustrate.

The principal elements of the Mediterranean group—hollies, laurels, olives, myrtles, etc.—with their narrow, elongated, coriaceous, entire or spiny foliage, only slightly divided, do not display the luxuriant fullness of tropical forms, but seem to lead toward them. They touch upon them on some sides, indicating the influence of a special medium, determined by conditions of intermittent heat and dryness. A peculiar feature of the Mediterranean group, and one which may help to determine its significance, is the capricious and uneven distribution in the interior region of plants of the most decided characteristics, evidently outside of the range of common species, manifesting affinities with hot country types. These species are narrowly cantoned in certain stations. The *Pinus excelsa* of the Himalayas is found only on a single mountain of Macedonia; the Algerine *Thuya* only in the Atlas; the false cork-oak in only a few specimens at a single spot; the carob at a few places on the littoral; the poplar of the Euphrates on the banks of the Jordan and at one point in the province of Constantine. Numerous instances of this kind betoken the existence of a former condition which has been more or less changed by subsequent events, that the group has suffered from revolutions which have displaced and partly eliminated elements that were formerly more widely distributed. The group has been impoverished, probably by the depreciation of some elements, certainly by the destruction of others.

This brief review of the forestal zones from north to south is sufficient for the study we have in view of the paleontological origin of the principal types of trees. This origin, which is at the best hard to determine, could not be sought with any probability, except as to those species concerning which we have data of a character to cast light on their history in the past, their former migrations, and their career through time as well as through space. Europe, North America, and the arctic zone furnish these data. They are not to be found in India, China, and Australia, for the guiding thread would be wanting there. Knowledge of many fossils is not enough of itself to conduct to the desired end. Vegetable impressions are useful indications, which, taken singly, have a relative value, but rarely lead to results of a material bearing.

Multiplied observations and discoveries, and fossil beds of unusual richness, to be explored at many points from north to south, have been required to give a view of the floral past of a part of the globe. It was also necessary that these beds, instead of belonging to a single period, should be frequently separated by long intervals distributed through successive ages, so as to present the complete picture of the series of past times. Thus a comprehensive grasp has become possible of the vicissitudes through which the vegetable kingdom has gradually undergone transformation.

Changes insensible at each single step have in the long run resulted in modifications of the aspect of the landscape and replacements of the types and species composing the floral carpet at a given movement by forms different from them, and also from those before which they were themselves destined to retire at a later period.

The impression which one feels in the midst of a deep forest is one of perennial duration. Except man, what is there to uproot those giants that have lived through centuries? What action can be conceived of that will exclude them from the ground which they possess so completely? The first impression would almost make these forest masses coeval with the globe, its natural product and spontaneous dress from the days of its youth. Such an impression would be a mistaken one. The forests have not been perpetuated in the same order from the beginning, but have changed much in the course of ages. Those which we now see have taken the place of other more ancient ones, and these substitutions have occurred many times, sometimes through partial modifications and sometimes also under such conditions that the old order has only indirect relations with the present one, or is even wholly foreign to it.

Since a serious mind can not suppose that at every revolution of plant-life there has been a total destruction of the anterior elements, followed by a creation conceived anew in all its details, we are forced to seek in the order which precedes the reason for the existence of that which has replaced it. This view implies an endless chain of causes and effects, of ancestral and derived forms, stretching along, now spreading, now continuing themselves, to spread out again, and—in what more particularly concerns the types of the vegetable kingdom—emigrating in a determined direction. This direction is found to have consisted, for plants, in a march from north to south in search of more favorable regions and stations better fitted to the exigencies of acquired adaptation, as rapidly as the terrestrial temperature declined from its pristine conditions, as latitudes took on their individual characteristics, and as the arctic zone, which had been temperate, grew cooler and became more and more differentiated. The polar circle was thus constituted a barrier that became more pronounced, less accessible, and was finally closed to arboreal vegetation, while under the operation of the same movement the present temperate zone became cooled in an equivalent measure, was impoverished, and gradually stripped of a considerable part of its floral wealth. The remnants that escaped this elimination in those successive and numerous retreats that filled the second half of the Tertiary period still occur, scattered and dwarfed, in the southern part of that zone, and upon points where the less sensible depression of temperature has permitted them to maintain themselves sporadically.

By regarding these considerations and this presumed march, we succeed in determining the connection between recent and fossil species, and evidences of affiliation between them. There also exist relations not to be neglected between some recent types and other old ones which we can not believe to be wholly lost, and others between present forestal groupings taken separately and those which have succeeded one another through the ages; but the further we go back, the more we address ourselves to a distant order of things, the less tangible are these relations found to be. Of all the Carboniferous vegetation there remain only isolated or dwarfed types, as of *Equisetæ*, ferns, and club-mosses. The singular Japanese gingko, and perhaps the dammara of the Indian Archipelago, can trace their ancestry back to that period. A greater number of estrays have survived from the Secondary ages; but they are still rare—auracarias, cedars, pines, thuyas, and a few colonies of cycads south of the equator. There has been something vague and undetermined about the "foliage" trees since they first appeared in the Cretaceous period; but their evolution and characteristic physiognomy have been tending to fix themselves. The magnolia, tulip-tree, plane-tree, ivy, etc., have hardly varied since then; but the subsequent modifications of other European flora have been so frequent and profound that no collection of existing species corresponds except by partial traits that have been questioned with the Cretaceous vegetation. The correspondence is somewhat closer with the vegetation of the Eocene, especially of the later Eocene. The examination of certain floras which are referred to this horizon has shown that vegetation has not varied much since then, except from the impoverishment which it has suffered by the subsequent elimination of some types, and the addition of a number of deciduous types of later introduction. Thus, a considerable proportion of forms, the ancestors of which appeared in the Eocene, have persisted in place from that epoch, while those which have since migrated are found in more southerly regions.

It is in the Miocene, particularly in the later Miocene, that the relations become manifest of the deciduous trees of southern habit which we have spoken of as being dispersed over various points of the Mediterranean domain—the plane-tree, the liquidambar, the planera, the linden, the vine, some hornbeams and ashes, the date-palm, the pomegranate, etc.; and the lauriferous grouping of the Canary Islands, preserved intact by means of its insular situation and of the persistency of local climatological conditions, reproduces unchanged the picture of a mountain-forest of central Europe, as recent discoveries have shown it to have been in the later Miocene and earlier Pliocene. There are the same species, the same mixture of laurels, hollies, olives, to which are added recent Japanese or Caucasian forms of nuts, maples, elms, and toward the high summits pines and firs very like those of the higher mountains of Teneriffe, Morocco, and Asia Minor. Collections made by M. Marion in the marly sediments of Durfort, where bones of the southern elephant were also found, and in the tufas of Valentine, near Marseilles, show that a number of plants now found only further south, still in the second half of the Pliocene inhabited the hills and shore-lines of southern France. These plants were then, therefore, at home further north than they are now found; and their occurrence in the Pliocene points to a later flowing back of species, amounting to a definite retreat in the Quaternary age.

This retreat, perfectly logical and almost regular in its operation, is connected with changes of climate, which were themselves in relation with a progressive depression of the temperature of the earth. It is connected also, in a parallel order of phenomena, with the exhaustion of some races, and with the development, by a concomitant origination, of other young and new races, favored by the same circumstances that caused the elimination of the races that gave way to them. Considering all the elements of the question, we find that it is by the extension, at a given moment, of vegetable races previously localized and realizing a certain amount of variation, that species are constituted at the start. Once characterized—that is, after the acquisition of a total of characteristics, at first fleeting, then hereditarily fixed—the species is permanent nevertheless only in a relative fashion so long as there exist in it parts susceptible of differentiation anew. The amplitude of the limits between which it may range through the course of time depends on the proportion of the elements that remain variable to those that will not change. The morphological oscillations of which it offers an example are thus determined by its own tendencies to submit more or less readily to excitations from without. Hence there are evident inequalities in the specific type, sometimes running to obscure shades, sometimes clearly cut; the last especially after the exclusion of intermediate forms.

There exist, in fact, fleeting species, which can not be circumscribed by any precise limit; and others, fixed in their minutest traits, that are susceptible only of insignificant variations. The forms of the latter category, such, for example, as the sequoias of America and the cedars of the Atlas, persist in the places of which they have once taken possession, where some of them have been driven back and cantoned, so that quite contrary conditions or the intrusion of more vigorous forms have not sufficed wholly to exclude them. We see, from this manner of looking at things, that the relations of the present arborescent species with those of ancient ages are only the last consequence of a march or an antagonism of long continuance, which must of necessity have left traces. Regarding this closely, we find the indices of filiation of the living by fossil species not wanting, but fully confirming our interpretation; and the genetic bonds disclose themselves to the investigator from the moment when he consents to regard the species as having acquired by degrees the characteristics which it possesses, and also as susceptible of displacement by extension or by crowding back.

The morphological connection has certainly the signification of a relationship; but it can and must vary according as the relationship is more intimate or remote, direct and immediate, or indirect and collateral. We can, by the aid of a direct method, rather led by a kind of intuition than subjected to precise rules, found a judgment concerning the bearing of these analogical shades. While the opportunities of observing forms nearly allied to those that are familiar to us diminish as we go back in the past, yet, at whatever age we place ourselves, a near resemblance always induces the notion of a direct descent of the recent form from the one which predicted its traits in the midst of an order of things remote from that which has since prevailed. The observed resemblance may also be conceived to be the more decisive as the species in which it appears belongs to a more ancient period. The indices of genetic connection may thus go far back into the past, and as to certain types of trees little subject to variance, they are discerned in a quite remote past. In order logically to reach precise conclusions, he who engages in such researches should take account not only of the type, but also of the species considered in itself, that is, of the state of race, with its particular history, of which it is sometimes possible to follow the incidents. So far as is possible, the type, or union of allied forms, derived originally from the same stock, should not be confounded with the species, or the particularized race, which, its characteristics having been once acquired and its aptitudes determined, necessarily assumes a march in harmony with the tendencies that distinguish it, within an area suited to it. The plane-trees, poplars, tulip-trees, beeches, and chestnuts appear toward the middle of the Cretaceous period, but it does not follow that existing forms are the immediate descendants of these primitive forms, or of any one of them taken separately. The traces of our plane-trees, the visible ancestor of the tulip-tree, and the evident predecessors of existing poplars, make their first distinct appearance during the Tertiary. So do those of the beech and chestnut, the introduction of which into Europe took place through isolated individuals, distinguished by shades which were gradually effaced on approaching modern times.

The principal requisite for tracing the presumed origins, whether of the type at its birth, of supposed ancestors, or of the direct antecedents of existing species, is to have in mind the exact succession of the periods and stages, giving the relative date of each of the determined first appearances and the order of the constitutive elements of the march which the forms of which we meet the traces have followed through time and space. The succession of ages, represented by beds deposited in a constant order, or stratigraphic geology, makes this known to us. It is also necessary to take account of the changes that have been impressed upon the whole vegetable kingdom during this long series of periods. The changes have been too profound, and attended by too complete renovations, for us to be able to find the cradles of existing plants in the primitive periods.

Three great plant-periods may be distinguished, starting from the moment when the surface of the globe first began to be covered with aërial vegetation: the primary or paleophytic period, or cryptogamic era, which derives its name from the domination of cryptogams; the secondary period, or mesophytic, during which gymnosperms—conifers and cycads—obtained the predominance, while foliage-trees were still absent; and the tertiary or neophytic period, also called angiospermic, from the presence of the higher plants and particularly of the foliage-trees.

The last of these periods, which began with the chalk and is still in continuance, is characterized by the appearance and extension of the higher plants, and was also coincident with the first signs of polar refrigeration and with the more and more marked decrease of terrestrial temperature with increase of latitude. This fact, at first hardly sensible, then gradually accented, exercised an influence within the polar circle before extending its action beyond, into the temperate zone, which was for a long time hot, and afterward warm, while the regions around the pole were already frozen. A remarkable relation certainly seems to exist between the beginning and the course of the climatological depression of the northern regions and the progress of vegetation, which perfected itself in a parallel line. Indeed, it closed the entire cycle of its definitive evolution by the adjunction of the angiosperms, the most perfect plants; and these acquired preponderance as rapidly as the cooling of the arctic regions went on. These regions appear to have been exempt till this time from the rigors of a cold season, and, by that fact, subtracted from the effects of the winter rest.

It is certain that the vegetable kingdom, as soon as it had acquired all the elements of which it is still composed, began to distribute itself in groups ordered according to the latitude; and this movement once started, the differences between the groups became continually more accentuated by the increasing exclusion in each of them of a part of the types which they originally contained. There resulted from this a constant impoverishment of northern countries as compared with southern ones, which gained, at least by contrast, what the former never ceased to lose. The movement has thus tended to a differentiation by zones, and has resulted in despoiling them, but in unequal proportions, increasingly as they are removed from the tropical zone, the only one which has been exempt from the spoliation.

Let us not forget that, parallel with this movement, working, moreover, with an extreme slowness and in harmony with it, another movement, purely organic and evolutionary, although incited, if not directed, by the former, has not ceased to push to development and to morphological differentiation various groups of plants; particularly of those which, relatively young and plastic, were susceptible, by this fact, of giving birth to new forms, and, by successive splittings, to new types. These are the angiosperms, which, having once gained preponderance, have offered the spectacle of an increasing multiplicity of races and forms. That multiplicity could only increase. The displacements resulting from the climatic depressions have aided in it by inducing changes of stations and opening new cantonments to races not yet fully established. The revolutions of the surface, continental contiguities, and the more or less accentuated orographic relief, have constituted other factors not less active in the general push of species, incessantly solicited to vary as they adapted themselves to the soil of the regions into which they penetrated, as they scattered, and as they struggled victoriously against rival species.

Such is the spectacle which the vegetation of the globe has not ceased to present; and the existing forests appear as the final resultant and ultimate consequence of that long series of alternatives which is summarized in the expression, "the struggle for existence."—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

The development of a new vegetation on Krakatoa is affording a rare opportunity for studying the origin of floras. The old vegetation was totally destroyed, with all its seeds, by the great heat that prevailed during the eruption, and the island was covered with a thick layer of cinders and pumice-stone. But in June, 1886, a new growth, of ferns and isolated plants of phanerogams, had appeared on the shore and the mountain. The riddle of its appearance in a soil apparently so unpromising was explained, on examination, by finding that the mineral had received a coating of fresh-water algæ, which gave it a gelatinous and hydroscopic quality, by virtue of which a higher vegetation could gain a standing. The phanerogamic plants are similar to those which take possession of newly-raised coral islands.

CHINESE MARRIAGE CUSTOMS.

By ADELE M. FIELDE.

SEXUAL selection, which has doubtless greatly influenced the development and advancement of certain races, has been inoperative in China during many centuries, because, under the prevailing usages, the contracting parties have, before espousal, no opportunity to judge of the strength, beauty, or intelligence of their consorts. Romantic love has no part in marriage or its issue. This may be one of the causes of China's arrested civilization, and of the astonishing fact that her astute people have invented nothing and discovered nothing during hundreds of years.

Although polygamy is legal, it is practically so expensive and inconvenient as to be uncommon among the masses. Under the law, no man may have more than one wife, though he may add to his household any number of helpmeets. The wife, brought home with unique ceremony, may under no circumstances be superseded in her well-defined sphere, the penalty of an attempt to put an inferior in her place being a hundred blows. In all cases the marriage engagement is made by the senior members of the families concerned, and is usually made without the knowledge of the future husband or wife.

Marriage being essential to the continuance of the line of worshipers before the lares and penates, a man who will not marry is reckoned guilty of filial impiety. Spinsters are unknown and bachelors are few. The universal and intense desire for posterity in the male line of descent leads to much self-sacrifice on the part of parents, in order to secure wives for sons, and causes them to make provident arrangements for their marriage at an early age. Betrothals of expected infants, conditional upon their being of different sexes, are not rare. Among the poor it is not uncommon for a newly-born daughter to be given away, that a girl of another clan may be taken by the mother, reared at her breast, and bestowed upon her son in after-years. In many families there is at least one little daughter-in-law that is being brought up in the house of her future husband.

Parents of moderate means endeavor to provide wives for their sons by the time they are twenty years old, while but few keep a daughter after she is sixteen. Those who have a marriageable son, and the means of meeting the expense of taking a daughter-in-law, place their case in the hands of an old female friend or of a matrimonial agent, called a go-between, who finds among her acquaintances that which is required by her client. The parents of the two young people do not meet for conference, and are not usually known to each other even by name. The negotiation is conducted by the go-between, who is the sole medium of communication between the two families. When all details have been settled, a sum of money is carried from the parents of the groom to those of the bride, and the betrothal is completed. This pact can under no circumstances be legally broken by either party. Even the discovery of fraud on the part of the agent does not vitiate the contract.

When the bride knows that she is to be married, she must evince by word and manner the deepest melancholy, and she gains commendation and repute if her lamentations are poetical. An acquaintance of mine, who was spoken of with approval, always, from the time of her betrothal to that of her marriage, referred to the latter as to her funeral. To her little brother—the only member of a bride's family that may before the birth of her first child visit her in her husband's house—she said, "When I am buried, you must come frequently to burn incense at my grave." To her elder brothers and to her sister-in-law she said, "After I am dead, do not kill the lizards and the centipeds that may crawl about the house, for it may be that my spirit will come back and dwell in the vermin about my home rather than abide in the grave into which I shall have been put." A gifted girl makes many such allusions without instruction, while the stupid have to be privately taught what to say when they wail their adieus to maiden life. How much of a girl's distress is real and how much of it is piously feigned can be guessed only by those who understand how deeply Chinese character is affected by Chinese customs.

The vexations of a betrothal and a wedding are so great as to have given rise to the proverb, "Don't say you have had trouble until you shall have married off a daughter or brought home a daughter-in-law." The sum of money paid to the bride's parents is usually spent upon her marriage outfit. The smallest dowry is a few suits of new clothing. The wealthy give hundreds of garments, and sometimes one or two bondmaids, with a field that reverts to the bride's family upon her decease.

In this, the Swatow region, the bride is always carried from her father's house to that of her father-in-law in a sedan-chair that is carefully closed and covered with scarlet. She is accompanied by none of her own family. The go-betweens and a messenger from the house of the groom direct the bearers who carry her trousseau with her in a procession along the streets.

Early on the morning of the wedding, the bride is bathed in water in which twelve kinds of flowers have been steeped; has her hair stiffened with bandoline and wrought into a marvelous coiffure with many golden aigrettes; is attired in gorgeous apparel, which she puts on with an appearance of bitter unwillingness, and enters the red sedan-chair weeping loudly. The marriage procession is headed by a man carrying a branch of a banyan-tree, whose local name is identical in sound with another word which means *completed* or *perfected.* It signifies the fact that all that is necessary to legal matrimony has been done in this case. This leader is followed by two men, each bearing a lantern on a stalk of sugar-cane, the former being a part of the bride's outfit, and the latter rising stage by stage to a climax broad and flourishing, symbolizing the hope that the bride's life may likewise widen out. The next in the file is a man carrying over his shoulder a bamboo, the emblem of rapid increase, having a red bundle of foot-gear on one end of it, and a red coverlet on the other. After him come as many burden-bearers as are necessary to carry all the red boxes containing the trousseau.

On arriving at the door of the house, the bride sees her husband for the first time, and recognizes him, among those who await her, by his rich attire. By previous arrangement, she is first greeted by some woman reckoned lucky and prosperous, in the hope that she will be like the one who gives her earliest welcome in her new home. A mistress of ceremonies that has been engaged to see that during three days all is done according to established usage, throws upon the door-sill some burning straw, half extinguishes it, and leads the new-comer across it, saying:

> "Now, fair young bride, the smoke bestride;
> This year have joy, next year a boy."

This rite is supposed to disinfect the bride from any evil influence to which she may have been subjected by demons or white tigers along her route. She then immediately enters the room in which her red bedstead has been set up, and in which her possessions are all deposited. There she sits silent all the rest of the day, among her red boxes, no one speaking to her, or noticing her in any way except by bringing her food. A feast is spread in the evening for male friends, who have been invited by card, and its preparation occupies the whole household. After the supper, the guests are permitted to see the bride, who is brought forward by the duenna toward the door of the bedroom. In some cases only those who can offer a felicitous stanza are allowed to approach the bedroom door, and there is much rivalry in the composition of poetry to be recited. The stanzas usually contain allusions to posterity, as in the following translations from the vernacular:

> "The bride is high-browed, fair and sweet;
> Like awls her small and sharp-toed feet.
> Brought home this year with honors meet,
> Next year an infant son she'll greet."

> "Fresh twigs upon the pine, new sprouts on the bamboo;
> The groom brings home the bride to rule his house: his field
> To her a thousand-fold its annual crop shall yield;
> And she will be a mother-in-law at thirty-two."

Practical jokes usually accompany the entertainment. Sometimes a guest enters disguised as an aged man, and after persuading the duenna to bring the bride close to him by a plea that his sight is very dim, he suddenly tosses off his cap and spectacles and appears as a hilarious youth. This creates much merriment. Another popular joke is to leave a bundle of fire-crackers under the bedstead, with a slow match so placed as to explode them after midnight, and this is often accompanied by an artificial shower falling through the roof upon the bridal couch. When the guests depart they frequently carry with them articles which they know the groom will require next day, and which he is bound to redeem from them with packages of confectionery. It is said that a merry company of the fellow-students of a groom decoyed him from his house after his wedding-supper, and fastened him to a tree in a copse, so that he should not be able to return home that night. His parents finally induced them to go to release him, but when they arrived at the copse they found he had been eaten by a tiger. To avoid probable discomforts, the groom sometimes conceals himself from supper-time until after the departure of all the guests. The fate of Ginevra would be possible to a Chinese groom, but not to a Chinese bride.

On the second day the young pair worship the images of the ancestors in the main room of the house, and make obeisance to each of the senior members of the family. In the afternoon the last presents are sent off from the groom's family to the bride's parents. They include pork, fish, cakes, and confectionery, according with the amount stipulated at the time of betrothal. During the second and third days all who choose may enter the house and view the bride, and the crowd of spectators is sometimes large. They say:

"We look at the new, and not at the old;
We all have, at home, old things to behold."

The third day is a busy one for the bride, as she must then formally begin her domestic duties. Early in the morning she washes clothes for herself and her husband, under the direction of the duenna. Then this mistress of ceremonies takes her hand, holds it upon the long handle of a ladle, and stirs up the food in a jar, from which she is to feed and fatten pigs. She meanwhile recites a rhyme, of which this is a close version:

"Stir up the swill, make the jar fume;
Raise hogs that are bigger than cows.
Stir deep and long, stir into spume;
Give thousand-weight swine to your spouse."

At noonday the bride cooks the family dinner, under the superintendence of her mother-in-law. In the intervals between other occupations she begins and completes the making of a pair of trousers for her husband. On no account must she be assisted in this task, or fail to accomplish it before the time for cooking the evening meal, else bad luck may follow all her subsequent career. Some time during the forenoon of this third day a messenger from her mother, usually her younger brother, brings her a bottle of hair-oil, takes dinner with her husband, and returns home accompanied by the duenna, who has then finished her duties.

On the fourth day the bride must rise long before daylight to dress her hair in the complex style of a married woman, and, as she is unaccustomed to performing this difficult work alone, she may succeed only after many trials. She this day lays aside her finery, and takes up all the occupations of a daughter-in-law, serving her elders in various ways, and doing the hardest of the housework.

If she hates her husband, and cares little for the comfort of her parents, she may waste food, break dishes, threaten suicide, and make herself so disagreeable that the family she has entered will soon consider the expediency of marrying her off into another household. If she desires to remain where she is, she strives to please her mother-in-law. A husband who takes the part of his wife against his mother is reckoned unfilial, and has little peace in the home of his ancestors. If he takes the part of his mother against his wife, the wife may be driven to suicide, and this would furnish opportunity for her family to make an inquisition financially ruinous to him. The mother and the wife, each jealous of the man's devotion, are the members of the family who are most likely to be unfriendly to each other. The existence of countless families in which three or four generations of both sexes live in apparent amity under one roof proves that the Chinese have great power of self-repression.

At the end of a month the bride's mother sends her a basket of artificial flowers, that she may make acceptable presents to her young neighbors. No bonnets or other head-coverings are used by youthful ladies in southern China, and flowers are worn in the hair on all festive occasions.

At the end of four months, on a day selected as lucky by a wizard, the bride goes to pay her first visit to her mother, unless some event has made it mystically unsafe for her to leave her present domicile or to enter her old one. The length of the bride's stay in her former home varies in different villages. In some she remains a month in her mother's house, and in others it is considered very unlucky if she does not return the same day, before the smoke from the village chimneys indicates that supper is being cooked. But any circumstance that renders either of the families unclean, and therefore unpropitious to luck, prevents the bride from having this outing. Uncleanliness is of two sorts—

that which results from a death, and that which follows the birth of a child. They are distinguished as that of bad fortune and that of good fortune, the former continuing three years and the latter one month. Were the bride to approach any unclean person, she would herself incur the danger of becoming an occult cause of calamity among her relatives. During the first few months after marriage she must carefully guard against exposure to any influence adverse to good luck.

A neighbor of a Chinese friend of mine had one daughter, an only child, of whom she was passionately fond. The girl was married off when sixteen years old. When the first four months were nearly past, her mother's neighbor died, and her visit to her old home had therefore to be delayed for a hundred days. Before this period of the neighbor's daily worship of the manes had passed, the bride's mother-in-law died, and she had to go into mourning for three years. Just before she put off mourning, she bore a son, and that made it necessary for her to again delay her first visit to her mother's house. Her mother, meanwhile, became subject to hallucinations, under which she frequently saw her child entering her door. She said she could distinctly perceive her face, could discern every detail in her dress, and could hear the jingle of her bangles. She would exclaim, "O my child, you have come!" but, when she clasped the vision, she found only empty air in her arms. At last the daughter, who had all these years been but two miles away, really came to visit her mother. The two embraced each other and wept aloud; and thereafter the mother's hallucinations ceased.

After the first visit, a married daughter may go to the home of her parents at any time, and they, after the birth of her first child, may occasionally go to see her in her husband's house.

NATIVE LIFE IN BRITISH BORNEO.

By D. D. DALY, Assistant Resident.*

THE author gave in this paper a personal record of two explorations which he undertook from the east and from the west coast of North Borneo to countries and tribes in the interior, hitherto unvisited by the white man. Having left Sandakan, the capital of the territory, in August, 1887, and ascending the Kinabatangare, the largest navigable river, the first place of importance reached is Malapi, within twelve miles of the famous Gomanton bird's-nest caves, and the depot for their product. The nests collected here are valued at $25,000 per annum, and the

* Abridged from the author's paper before the Royal Geographical Society.

caves bring to the North Borneo Government a yearly rental of $9,000. One of the vaults in the caves is estimated to be nine hundred feet high. An idea of their population may be got from the statement that a steady column of the swifts (*Callocalia*) inhabiting them has been timed by the watch to fly for three quarters of an hour from one of the apertures. Passing Bod Lagit—"which means the hill to the skies, a legend recording that it formerly reached to the heavens, but, owing to the wickedness of its inhabitants, had subsided to its present height of four hundred feet"—and a hill of limestone called Chuko Besar, which contains some small caves and yields a few hundred bird's-nests each year, the explorers visited one of the owners of the Batu Timbang caves, of which two native rajahs share the proceeds in alternate years. They are situated on the river Quamute, a branch of the Kinabatangare, and are difficult of access on account of rapids. Some of the bird's-nests are of the best white description, but the larger proportion are gray and mixed with feathers. Still further up—three hours' climb from the Melikop branch, and eighteen hundred and ten feet above the sea-level—are the Obang-Obang limestone caves, which had not hitherto been visited by Europeans. The first cave reached after a three hours' climb, the last half-hour of it over slippery, moss-grown, limestone bowlders, is the most valuable, but can be approached only by experts in climbing. The entrance is a small hole, four feet by four feet, and is closed by a wooden grating so as to attract attention to the spot, as otherwise the unwary traveler might suddenly be precipitated to the depths below. Every two months this doorway is opened, and the climbers let themselves down into the caves by means of rattans, and gather all nests, large and small. This makes six seasons per annum. The same periods are observed in the collections at the Senobang caves in the Ulu Penungah. "The seasons at Gomanton, Batu Timbang, Madai, and Segalong number two or three during the twelve months, and these are too few, according to the Tungara tribe. They maintain that, by collecting them frequently—say six times per annum—they procure white nests in first-rate order, though some of these nests are young and but half formed, and that the Sulu traders give them a higher price in consequence. I noticed a great scarcity in swifts and a great preponderance of bats, which might be attributed to the too frequent collection of nests, which prevents the swifts from breeding. The Obang-Obang Mountain runs north and south, and is half a mile in length. There are seven entrances to the vaults from the top of the range, all situated close to each other. Five of these vaults do not contain any bird's-nests, there being no swifts, only bats dwelling there." The only chamber that can be entered by any one who is not an adept at climbing on rattans to the roof of the vault is only fifty feet high, and contains both bats' and swifts' nests. The bats' nests are similar in form to the swifts', but are made of moss only, which these mammalia pick off the limestone bowlders outside.

At one stretch of the lower Kinabatangare several villages had been abandoned some years previously on account of the ravages of small-pox. When asked their age, many natives would answer that they were so many years old at the time of the last epidemic of this disease. The usual interval between the visitations was eighteen or twenty years; and the old men would sometimes acknowledge to having seen the ravages of three or four epidemics. Another settlement had been abandoned on account of the voracity of the crocodiles, which had mastered the art of overturning boats and devouring their occupants. The crocodiles are very numerous in these fresh-water rivers, and many natives are taken by them every year. At a place further up the river, a large one, fourteen feet long, was towed to the bank close to the house where the author was staying. "There was much joy manifested by the Muruts at its capture, as it had eaten a brother-in-law of the chief. Pieces of the bones and skull were found inside, and brought to the house with a good deal of merriment. A chief who has many wives has usually many brothers-in-law, and he is obliged, in a measure, to assist or support the latter. The loss, therefore, of a brother-in-law more or less is not only immaterial, but rather a merciful dispensation; and so there was as much joy, feasting, and congratulation as if Maharajah Oban had been presented by one of his wives with a new baby."

"The Murut," we are informed, "does not wear any clothes, but sports a bit of bark in front; some strings of colored beads encircle his head, a few charms hang around his neck; he carries a spear as though he feared no man, and annexes a new wife when he is 'off with the old love.' The women and children are much neglected."

Where the river passed through a large uninhabited jungle-forest, "in both banks were compressed heaps of leaves and wooden *débris* from four to ten feet thick, that had been washed down by floods. Where the river-water had washed part of the layers away, the section of the bank presented the appearance of a cutting in a hay-stack. These large deposits, if undisturbed, may, after many centuries of compression, form into coal. At a station near the Batu Timbang caves, where the traveler negotiated with the rajah proprietor concerning the proceeds of the bird's-nests, a dance was given in his honor. In the favorite figures the women, holding each other's hands, moved in one circle, while the men, also holding hands, moved in an outside circle, but in the opposite direction—to the sound of music composed of gongs tuned to different keys, and wooden drums. The next entertainment was given by a party of some twenty men and women performing an incantation over some medicine which was to be administered to the chief. "They all held palm-branches in their hands, which they waved in graceful unison and in perfect time to the melodious cadence of their voices. The women sang one line, and the men took up the solemn refrain in a sort of Gregorian chant. They danced gracefully, holding each other's hands, in a ring around the mysterious object of their charms; both the dancing and singing are continued until the sorcerer declares that the spell has been worked over the medicine. It should be stated that the Tamhanuahs declare that after death their souls find rest in peace on the top of the great mountain Kinabalu, as their forefathers believed before them." A curious mausoleum was visited at Imbok. It was built of solid bilian-wood, a material of long-lasting qualities, and the ends of the prettily ornamented and fluted posts and beams were carved into grotesque heads of animals. It contained some thirty or forty bodies, and was surrounded by fruit-trees.

At Pemengah, where a police station was established, many of the traders were found living and keeping their stores in houses built upon large bamboo rafts, called lanteens, which were made fast to the banks by rattans. The people at one of the villages near this place had never seen a white man before, and when Mr. Daly first arrived the women and children ran away and hid themselves in one of the back rooms, and the men looked "nervously suspicious." They examined his arms and chest, and were very merry at the idea of his skin being white, "which they seemed to think an absurd freak of nature. . . . They all smoke from morning till night, and out of pipes that have brass mouth-pieces and large bowls, such as are used by the Dusum tribes of the west coast. The tobacco is grown by themselves, and retains a green color by their process of fermentation. . . . They have not yet learned the use of guns or of gunpowder. They had not previously seen a double-barreled breech-loader, and when I opened mine to put in a cartridge, they exclaimed, 'Oh, it is broken!' I brought down a few of the swifts that build the edible bird's-nests, and found them to be very small, and to have a patch of white on the back and tail. The men wear only the loin-cloth; the women have but one garment, viz., a short petticoat, which is kept up around the waist by coils of brass wire; the young girls have, as an addition, coils of brass wire from the ankle half-way up to the knee. The cloth is woven from the thread made from the cotton-trees, *kapok*, that grow luxuriantly around their houses, and the women use the same kind of spindle for making thread as is common among the Dusums of the west coast, holding the cotton in the left hand and occasionally giving a twist to the spindle with the right hand. The people know of no other minerals besides coal and iron pyrites. Their houses accommodate from ten to fifteen persons, and they do not keep pigs under their houses as other sea-coast tribes are in the habit of doing. Their sleeping-hours are peculiar. No bedding is used, but they sleep on mats till about midnight, when they wake up shivering with the cold of these inland mountains. A fire is then lighted on a large, oval-shaped hearth, that is made of clay in the center of each house, and all the inmates, young and old, sit round the fire until dawn in a crouching attitude, telling long-winded stories, sometimes nodding, and sometimes leaning against his or her neighbor with head resting on the knees. Their chants at night-time are doleful and monotonous in tone. For striking a light, the men carry in their waist-belt a small bamboo prettily carved, in which some tinder and a bit of porcelain are kept out of the rain. By holding the tinder and the piece of broken plate in the right hand, and striking it sharp on the side of the bamboo, the tinder is ignited."

One of the objects of the expedition was to put a stop to the head-hunting raids between the Murut tribe and their traditional enemies the Peluans, the latter not representing a particular tribe, but the aborigines of the interior generally. "The Muruts are very frank in naming and numbering the heads they had taken; and I found the debit and credit account to be as follows: The Muruts have taken twenty-six heads of Peluans, the Peluans have taken thirty-one heads of Muruts; balance in favor of the Peluans, five heads, and also four Muruts who were wounded in the last affray. Each tribe distrusts the other, and peace can be only made by the Peluans paying a commensurate amount of blood-money in compensation for five heads that stand against them." Word was therefore sent to the Peluans to come down to a parley at an appointed time, with guarantee of safe-conduct. When the chiefs of the two sides had been brought together, "the Murut chiefs commenced taking the oath by chopping at a stick or sapling with great vigor, repeating the words of the oath with a loud voice, until toward the end they appeared quite excited. A Murut chief took the oath and then a Peluan, turn about, and, as each oath takes six or seven minutes to repeat, it took a long time. The following is a *précis* of the form of oath, each + denoting a chop at the stick, until it is finally chopped into little bits: 'I follow the Government of the British North Borneo Company +. The Sandêwar + and the Peluan + people are now of one mind +. If I kill a Sandêwar" (if a Peluan is swearing) "man + when I go to the water, may I not be able to drink +; when I go to the jungle may I not be able to eat +. May my father die +, may my mother die +, may my house be burned down +, may the paddy not grow in my fields +, may a crocodile swallow me +, may the eggs never be hatched in my fowl-house +, may I never catch a fish when I go fishing +, may my life be ended +. I cut this stick + as if I was chopping my own head off +. The Great Spirit is my witness +. May this stick grow into life again + if I ever kill or take any more heads +, and I follow all the customs of the British North Borneo Company +, and I take this oath with a sincere heart +, and I shall pay the poll-tax of the company +."

One of the Murut chiefs "was chopping away at the stick, repeating the oath in a loud voice, when he came to the part 'may my wife die' (if ever I take another head), when he stopped short and exclaimed with a grim smile: 'I have no wife; you Peluans cut off her head long ago'; and the Peluans gave a shout of laughter in which he joined, the crowd around rolling on the grass, convulsed with merriment. This would denote that the retaliation in taking heads does not proceed from a spirit of affection for the departed relatives, but rather from a sense of revenge or *vendetta*, engendered by a feeling that shame has been cast upon the tribe by losing one of the family at the hands of the enemy. Another illustration of the indifference with which the people regard the head-hunting custom was afforded at a chief's house where fifty-two human heads and pieces of human bones were hanging from the rafters. The skin of some of the faces was so well preserved that the expression could still be recognized." Mr. Daly explained that he could not eat his evening meal in a room where these were suspended, and asked that they be cut down. This request the chief and his sons "cheerfully complied with, but with a bland smile of patronizing pity at the white man's amiable squeamishness; and so to humor me they took down the ghastly trophies, and, huddling them together in rattan baskets, put them away at the back of the house; doubtless they were reinstated as drawing-room ornaments after my departure."

It is claimed that great improvement in the order and civilization of the country, and in personal security, has already resulted from the occupation by the British North Borneo Company.

The higher scientific deductions, which could not have been reached without the aid of a faculty in which imagination had a share, are in standing contradiction to the often-repeated *dictum* that science is void of imagination and the play of thought. Newton, Kepler, Bacon, Helmholtz, Lyell, Owen, Darwin, and Pasteur, are cited by a writer in "The Lancet" as scientific investigators representing the very highest type of intellect, in which the insight and imagination of the poet were united with the capacity for severe and sustained observation. To represent scientific study as affording no play for emotion is false. "No poet's fancy can equal in grandeur the two twin generalizations of science, gravitation and evolution—the one binding together the universe of matter, the other uniting into a harmonious whole the universe of life."

ANIMAL ARITHMETIC.

By Madame CLÉMENCE ROYER.

ALL degrees of arithmetical aptitude may be found among the human races, from the genius of a Newton and a Laplace to an absolute inability to conceive the abstract notion of number aside from concrete facts furnished by direct perception. The savage is not deficient in the perception of the multiple. He never confounds one tree with two, or two with three, or four; and is well aware of the difference between two, three, or ten men, when he is going out to fight them. The thing that he can not do is to abstract the idea of a number from the things to which it is attached, and generalize it, without reference to the concrete objects with which he has seen it associated. He may comprehend two, because it is associated with his two hands and his two feet; three, by the aid of the triads with which he is acquainted, and of the triangle with which those objects may be arranged; four, from the four limbs of animals and the four corners of a square. But his ability to form such conceptions is very limited. The first steps in learning in this direction, in savages and children, are to distinguish the abstract notions of unity and plurality, and in plurality, of two and three from larger pluralities. The difficulty in the way of their reaching a concept of abstract numbers is their inability to form a mental representation: four trees not being identical in the savage's thought with four stones, he can not imagine that there is anything common between them. Nevertheless, he can distinguish clearly enough between four trees and three others, and the two groups will leave quite different impressions in his mind. Four trees in a row will also make a different impression from four trees in a square. He is most struck with differences of distribution in space, and derives from them his notions of differences in plurality. While he is a poor arithmetician he is a good geometrician.

It is by the exercise of this faculty that he finds his way so readily where he has once gone. He recognizes a wood he has been in by the relative distances apart of the trees, their heights, sizes, the inclination of their trunks to one another, the profile of their masses, and their kinds. He learns the landscape by the relief and accidents of the ground, the wave-lines of the horizon, and a thousand details which he fixes upon his memory by a single keen observation so clearly as to give imagination no chance to play tricks with him. He estimates distances by the weakening of tones and the convergence of the lines and planes of the perspective. But in all his comparisons of present and past sensations, definite notions of number rarely have any part.

The inequalities in the development of the power of counting and of arithmetical notions among the different human races should make us cautious about accepting the accounts of those who believe that some animals can be taught to count. It is extremely improbable, at least, that animals, however intelligent, without language, should acquire precise ideas which human beings succeed in apprehending only by the aid of language and education.

The animal can distinguish relative sizes, but the measure of quantities escapes him. Like the child and savage of inferior development, he can only distinguish between few and many, between unity, duality, and plurality, the various degrees of which must inevitably be more or less confused in his perceptions. He knows facts, but he distinguishes them chiefly by their order of coexistence in space, rather than of succession in time; and they are photographed in his brain in views of the whole, of which, not being able to separate them from the others, he can not distinguish the similar parts enough to count them. His recollection of places is a succession of kaleidoscopic pictures, in which, among the moving forms and successive sounds, he marks only what moves him, what gives him pleasure or pain, what flatters his instincts or answers to his wants, what arouses fear or desire in him. If he should go so far as to count, it would be only those objects which interest him with a view to his security.

The wolf and the fox, for instance, can distinguish whether a flock is guarded by one or two dogs, but can not tell any better than we can how many sheep there are in the flock; but if they see one or two separated from the rest, they will attack them. In the same way we can distinguish the forms of two, three, or four poplars on the bank of a stream, while we can not tell the number of trees in an avenue, but are always inclined to exaggerate it.

It is by this observation of lines, directions, and signs in the whole, rather than of numbers, that the animal acquires the faculty of recognizing roads it has passed over, and places where it has met its prey or escaped its enemies. It can orient itself to the horizon and measure distances, as the savage does; and, like him, it has the sense of the direction it ought to take to reach the object it is in search of; but it is reasonably certain that no calculation of any number of units enters into this intelligence. When a dog in hunting crosses a wood or a fallow ground, he is able, by a quick apperception, to describe all the curves and all the angles that permit him to avoid or turn the obstacles. He can adjust his leap to the width of the ditch which he has to jump, and find the point where he can pass a live hedge. This mechanical instinct is exercised spontaneously in him, by virtue of exact theorems of which he has no analytical consciousness, but which he applies with a precision that defies the ingenuity of mathematicians. Force, speed, mass, space, and time are calculated in an equation in which the means are closely adapted to the end, with a marvelous economy of efforts, and by the quickest if not always the shortest way.

In his relations with man, attentive to the will of his master, whose language he has learned to understand, partially at least, the dog comprehends whether he must go or come, run or stop. But he attends less to the phonetics of the words than to the intonations of the voice, the direction of the glance, and the gestures.

The horse knows whether he is to go to the right or left by the energetically pronounced interjections "gee" and "haw," but he measures the extent to which he must veer in either direction by the pull on the bridle, so much as to turn quite round if the pull is at once energetic and quick. If the strees is equal upon both sides, he stops abruptly on his haunches. He learns the language of the stable in a very short time, much less than it takes to train the horseman. But there is no notion of numbers in it, although the horse is very sensitive to musical rhythm.

We can not, at a glance, estimate the number of men in a regiment, but we can calculate it rapidly, when we have noticed the number in a line, the number of lines in a company, and the number of companies. We are still more incapable of distinguishing one hundred points in rows from ninety or one hundred and twenty, without dividing them into tens. But an animal, which has no faculty of numerical abstraction, or of unities of different orders, or of multiplication, would be absolutely incapable of performing this operation. When small numbers of concrete things are in question, however, the aptitude of animals to distinguish these numbers is evident, and is, moreover, indispensable to their existence. A wolf or a boar, which could not perceive how many dogs were attacking it, would not know how to defend itself; but, if it counts them, it is by means of the tactics by which it opposes them, and in which it follows geometrical rules; for if four dogs attack it, two on the right and two on the left, it retreats, facing them, so as not to be between them, but to hold them as much as possible in front and within reach of its tusks. But if the pack is too numerous, the animal becomes wild, loses a clear notion of the number of its adversaries, and bites at hazard the one which presses closest upon it. A man in a similar situation would do much the same.

Birds have at least a vague idea of the number of eggs in their nests, for we can not take one out without causing in them a disquiet that becomes greater if we remove more. But they manifest a like distress when their eggs are only disarranged. Is this because the geometrical arrangement of the eggs is changed? Five eggs or four make a symmetrical arrangement as the bird disposes of them. But if some are taken out, and three, or two, or one are left, the disposition is very perceptibly changed. When the little birds have been hatched, the differences in their size, liveliness, figure, and voice, give the mother a means of distinguishing them individually. And even the eggs are perhaps not so indistinguishable to her as to us; for sexual and maternal instinct conveys special faculties in these matters. The domestic fowl seems to be less intelligent in such things than sparrows and other wild birds, but this is because domestication has modified her instincts.

Cats certainly know how many kittens they have, but they seem less affected by the loss of one of them according as more are left. If the mother loses one of four or five, she seeks for it a little while with considerable anxiety, and then becomes reconciled to the loss. If only one is left, she becomes greatly troubled, and, if that is taken from her, her distress appears extreme. This may be because of the pain she suffers in her teats when the milk ceases to be removed. When the young have become weaned, she can witness their disappearance with apparent indifference.

Dogs have been observed on various occasions to exhibit primary numerical perceptions in the concrete. When there are a number of them in a house, they quickly remark the absence of one of their companions. But they are rarely troubled by it, and make no effort to find the missing one, and they are still more ready to take notice of the absence of one of the members of their master's family. These traits are more easily explained by the clear knowledge which dogs have of individualities than by ascribing to them notions of unities as forming parts of numbers. The unequal degrees of attachment which they show for the different members of the family, and for the different persons who live in the house or visit it, proves that they make great differences between them. The idea of difference between several persons involves and supports a notion of their number. But it may lie there if wrapped up in their total perception.

Hounds pursuing a hare are troubled for an instant if they raise another one, and will sometimes stop, as if they were uncertain which one they ought to follow. Good dogs will not allow themselves to be diverted from the scent of the first animal, which they have already tired. When the setter pauses before a flock of partridges, the movements of his head and eyes follow the birds that stray to the right or left. If the flock is large, he can not estimate their number, nor can the hunter. The shepherd's dog watches his flock of sheep, and goes after the individual members that wander from it. But if one or two of them have been sold or carried off by a wolf during his absence, he does not miss them.

It is wholly improbable that the so-called learned dogs, which are said to have been taught to count, have really been lifted to the abstract notion of numbers. They have simply been taught to associate certain signs or words of their master with particular graphic signs, the geometrical figure of which has been impressed upon their memory. In the same way that the horse associates the words "gee!" and "haw!" with his right and his left, and dogs associate the sound of the horn or trumpet with the chase, they may associate with figures which are shown to them the names as pronounced of those figures, but without comprehension of their numerical relations, and without distinguishing them in any other way than by the difference in their shape. They may be taught to arrange them when commanded in any particular order, without it being necessary to suppose that they have any idea of their arithmetical significance.

When Sir John Lubbock speculated about teaching his dog to read, he played upon this faculty of associating vocal signs with certain forms or figures, and even with graphic signs, figures, or letters. The dog certainly had no comprehension of the ideographic value of the figures which were shown him drawn upon the pasteboard; but their shape, stamped in his memory, was associated with the sounds that were spoken to him when they were shown him, and with certain acts that he was to perform to obtain caresses and rewards from his master. He thus soon learned to pick out the cards which he had to bring to ask for drink or food or to go out in order to have his desire satisfied. The quickest way of teaching children to read is to show them at the same time the image of the object and the word that designates it, so that the two shall be associated in their minds, and they are tempted to speak in the same way. But to appreciate the abstract sense of the noun or the verb requires a degree of intelligence and faculties of comparison which none of our domestic animals has as yet attained.

It would, moreover, be very extraordinary to find in an animal so far removed in organization from man as the dog a *quasi*-identity of mental faculties, and an educability which is wanting in entire human races. It is enough to show that between the intellectual state of dogs and of Bushmen, Tasmanians, and Veddahs, who can count only two, and then say "many," the difference is as slight as possible, and the passage insensible.

It is, moreover, evident that horses and dogs know as well as a savage that they have four limbs. Foxes caught in traps will use the most ingenious devices to extricate themselves, and will even gnaw off one of their paws rather than be prisoners. This requires an effort of the will contrary to the instincts, surpassing the degree of moral energy of which most men are capable; and, further than this, the act demonstrates a power of applying means to the end, which is an act of intelligence not less complicated than the effort required for counting twenty on the fingers and toes, as is the manner with most savages.

The faculty of abstraction and generalization is developed exclusively by the aid of descriptive and ideological language, which classifies things and acts under different words or auditive images. With inferior races this faculty is weaker in proportion as their language is less analytical and less rich in abstract terms. It is impossible to excite it in an animal, because, in the absence of a language common to man and him, he is destitute of every means of acquiring it. There is really no bridge between animal and human intelligence. While our language, being descriptive and objective, associates a sound with each visual image, the language of the animal only expresses emotions and passions. As a rule, it is as untranslatable to us as our language is to them. It is only when we try to paint, describe, relate, and express ideas, that they can not understand us, for nothing is easier than to cause them to share our emotions, tenderness, anger, or hatred. They understand our mimicry better than we can understand theirs, and by mimicry we can make them understand the causes of our emotions of a certain kind. The only condition is, that we be dealing with species of a social nature.

When a hunting-dog sees his master with his gaiters, carrying his game-bag and gun, he understands that he is to go with him. He may even have acquired the habit of associating the recollection of a sound with these objects, and thus know the names by which we designate them in the language which he hears us speak. He may also be taught to fetch the gaiters, shoes, and game-bag when told to do so. If, when he has brought one shoe, he is told to fetch the other, he understands that there are two. To this point he certainly has the notion of duality. He can not be ignorant, after he has executed this order several times, that the words "the other" mean the second shoe. If, after having been trained by an English master, he passes over to a Frenchman, he learns that his order *l'autre* means the same thing. He takes no notice of the difference in the sound of the words, because they are both uttered with the same accentuation and intonation, and under the impulse of the same feelings. To him human speech is a yelping, which he interprets by the same rule as he does his own ejaculations.

A second unit, added to the first, is in reality the beginning of all numeration and the foundation of arithmetic. As there are human races that have never gone further, we need not be surprised if animals stop there. But they do not stop there. They go on from this by successive additions, while we have reached the stage of multiplication, and have framed arbitrary systems of numeration, and have thus made of calculation an art founded on ideal notions. Animals, on the other hand, have a concrete notion of numbers more highly developed than we suppose, and perhaps more highly developed than it is with us, in proportion as abstraction is less easy with them. We need not suppose that the animal is destitute of all abstract notions and incapable of all generalization. Far from it; but the general notions being made of resemblances and the individual notions of differences, it is more struck than we are by individual characteristics. In this it again approaches the child and the savage, neither of whom has the generic notion of man. The child has the individual notion of its mother or its nurse, whom it distinguishes from all other persons around; but the generic notion, composed of all the common traits of the persons around, is of slow growth. The languages of savages are, for the most part, wanting in words for *tree* or *animal*, to comprehend the class, but have definite names for all the trees and animals that are useful to the tribe, or which they fear. We, therefore, may affirm that the dog has no generic idea of man, animal, or plant, but only ideas of particular men, particular women or children; and that every species, whether of animal or plant, is thought of by it as a representation of its individual figure, with all the differences that distinguish it from the others that it has seen. Our imagination by itself can not bring up the idea of an animal or plant which is not a particular animal or plant; and any effort we may make in this direction will end in there passing through the mind a succession of images of different animals and plants. If the use of generic names is taken from us, the general notion will go with it.

In the absence of articulate and descriptive language, and there being no object competent to serve us as a phonetic and auditive representation, we would think directly of things by a kind of precise interior view that permits no error or verbal sophism, and not as by a kind of internal audition that tends to replace things by their names, that makes us speak our thought within ourselves before speaking it aloud, and which we mistake as well as deceive others, when the interior definition which we give to the words does not correspond with the thing defined. It is especially difficult, in the absence of a common language between man and the animal, to make the latter comprehend what we require from it, and the object of the acts which we solicit it to perform. The dog has no desire except to obey and please us; the trouble is in explaining to him what we want of him.

A dog had been taught to go, when commanded, to the shed for wood for the fireplace. The exercise amused him; and, when he had brought one stick, he liked nothing better than to return for another, so that he had to be told to stop. But one time, when he was alone and lonesome, he pulled down all the wood, stick by stick. He had not comprehended the purpose of the act which they made him perform, supposing it to be a sport, like the ordinary carrying of a stick. Could this dog have been taught to count by sending him for two sticks and then for three, and so on to larger numbers? We doubt it, because he had not even disengaged from the act which he was ordered to do the general idea that all the pieces of wood which he brought were to be burned in the fireplace, that he was never sent for them except for that purpose, and that he should only fetch as many as were needed.

If efforts to educate animals have been even more fruitless in the hands of scientific investigators than of workingmen proceeding without theoretical views, it is because great errors have been committed in the analysis of human faculties, in making such suppositions, for instance, as that arithmetical notions are more elementary than geometrical ones. Having done this, they have sought to teach animals, whose capability is for measuring, to count. Having become habituated by our industrial civilization and the economical laws of exchange to the intervention of the idea of number in all our wants, acts, and works, we have lost perception of the insignificant part which it has in animal life as compared with that of the idea of size. Animals have a very exact sense of size. They can measure time and distance better than we can. The sparrows in our parks, when affecting the highest degree of confidence in us, know how to keep just enough distance from us to be able to evade us. It also seems to be demonstrated that all animals have more or less of the faculty of estimating the number of objects coexisting in space; that is, in a varying degree, of analyzing the similar or identical elements in their visual or auditive perceptions, so long as the number is small enough.

Have they also the faculty of estimating numbers as successive repetitions of the same facts in time, or of counting the reiteration of the same perceptions? I was once told of a workman who was in the habit of giving sugar every day to a dog which he met in going to his work. The dog counted on his daily return. He gave three pieces of sugar, one after the other, and the dog would wait and look till it had got the third piece, when it seemed satisfied and did not ask for any more. It had, therefore, the notion of these three successive facts, and could count them. I learn from good authority that a tame sparrow was accustomed to go out daily from the house where it lived in freedom just before it was time for the children to come out from school. It would wait at the school-house door for a child of the family with which it lived, and return perched upon its shoulder. One day it went out but did not return, having probably fallen a prey to a cat.

Nothing is more frequent among animals than daily acts at fixed hours; but we have proof also that animals can measure longer periods. A dog was used to go every Saturday evening for his master, who came to spend Sunday at home, and went away again on Monday. But the dog, instead of following his master away, showed his displeasure at the parting by sulking in a corner. Could this dog count the six days of the week during which his master was absent? It is more likely that his return was foreshadowed by certain things going on in the house that only occurred on that occasion.

Houzeau de la Haie tells of a pelican living in a fisherman's family at Santo Domingo that was fed upon the refuse of the fish-cleaning. Looking for its food, it went to the shore every day and waited for the boats to come back. The fishermen rested on Sunday, and the bird acquired so clear a notion of the return of that day, when it had to fast, that it would not stir from the tree on which it was accustomed to spend its time. It is not necessary to suppose that the pelican had learned to count the six days at the end of which its masters would not go fishing; but, while it really estimated daily the time when it must make its excursion to the shore, it was informed of the return of Sunday by observation of what was going on in the house, as, for instance, by the fishermen putting on their Sunday clothes; in the same way as the dog knew when its master was going to hunt by seeing him with his gun and game-bag. In such instances, animals show that they have the faculty of associating ideas, of observing consecutive facts, and establishing a correlative connection between them—things which have been proved by abundance of other evidence, and which demonstrate not less intelligence than acquaintance with the ten signs exposing the first ten numbers, or the use of a system of numeration to express larger numbers.

Broderip tells of an English Protestant minister's dog which escaped every Sunday and followed its master to church. It was shut up on one Saturday evening, but on the next week when they went to shut it up it could not be found, and hid itself till the service-hour on Sunday, when it appeared again at the church. In acting thus, it had evidently reasoned out all its conduct, displaying memory, foresight, and calculation. It is not likely, however, that it acted upon a count of the days, but rather on the knowledge that it had to turn the spit on Saturday, or the day before its master went to church.

If this period of the seven days of the week does not exceed the intelligence of a dog, the dog should be able easily to measure periods of two or three days. Houzeau says that he tried for three consecutive weeks to repeat the same walk with his dogs, every two days at exactly the same hour. It would have been enough for them to count two to determine the period. On the twentieth day, or the tenth periodical repetition of the excursion, although the dogs enjoyed the excursion exceedingly, he never remarked that they anticipated it spontaneously, or had a thought of it before witnessing his preparations to go. From this, Houzeau concluded that dogs could not count the days. But when actions repeated daily at fixed hours were in question, the dogs knew when the time came. Broderip's dog and the Santo Domingo pelican had learned, in the course of years, that the same succession of events took place every Sunday. It was not, therefore, by an isolated fact, but by an aggregation of facts, that they became aware of the return of that day; for not only did certain things take place regularly in the family, but Sunday noises, like the ringing of the bells, and unusual comings and goings, occurred in the place. After continued experience, the animals acquired knowledge of the succession of the events, and governed their conduct accordingly.

Houzeau also learned that some animals are capable of measuring lapses of time that particularly interest them. He says that female crocodiles abandon their eggs in the sand for ten or fifteen days, according to the species, and return to the spot at the exact time when they are to be hatched. It is easily conceivable that animals have, in general, a more precise measure of periods which concern the needs of their organic or specific life, than of the more artificial periods to which they have become habituated in the domesticated state or in consequence of their relations with man, because an hereditary habit has always more force than habits acquired by education.

Houzeau cites facts showing that some animals can count the number of similar objects or acts, provided the numbers are not too high. When a magpie is watched by a company of hunters, it will not move till they go away. If they go one after another, it can not be deceived by one of them staying behind unless there are more than four of them. Another story of similar bearing is that of the tramway mules at New Orleans, which are relieved and fed after making five trips. They make their trips patiently and quietly till the end of the fifth, when they give evident signs that they expect their usual refreshment. The horses in the coal-mines of Hainault make thirty trips a day, taking their places again, after every trip, at the head of the train, in readiness for the next trip; but at the end of the thirtieth trip they turn their heads in the opposite direction, or toward the stable.

Facts of this kind ought to be tested by most precise experiments bearing upon the conditions under which they are produced, and upon different subjects. Are not the horses warned of the end of their stint by some exterior sign, such as a change of conductors, the departure of a squad of workmen, or the arrival of the horses that are to take their places, or by the meal-hour? Is not the conclusion that they count the number of their trips arrived at too quickly?

It would predicate a very high degree of development to suppose that a horse could count up to thirty in any given number of hours. A man in such case would nearly always make mistakes, unless he had some means of registering the trips as they were completed.

It is nevertheless established that some birds and quadrupeds are capable of counting up to four or five, and perhaps more. It can not be disputed that the higher limit of this faculty may vary according to species, and also to individual traits, since the mathematical faculties of men are very great in their variations. But we have reasons for believing that the geometrical faculty in animals supersedes the arithmetical faculty, and that the latter has been developed in man under the influences of industrial civilization and commercial exchanges, which have, in nearly all cases, caused the notion of numbers to be substituted for that of measure.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF F. A. VULPIAN.

THE name of Vulpian is associated in some way or another with most of the important physiological discoveries of the age. It is, according to Dr. Charles Richet, because, whenever a new experiment was published, he took it up at once, tested it, and perfected it, toning down with his critical and judicial spirit the exaggerations and rectifying the errors in the accounts, and, making the general application of the newly gained fact, gave it the right to be quoted as good physiology. Thus he cast light on all the problems which he grappled with.

Edme Felix Alfred Vulpian was born January 5, 1826, and died in Paris, May 18, 1887. He was the son of a distinguished French lawyer, and was graduated in medicine in 1854. He was soon afterward appointed to the Museum of Natural History, where he conducted a series of investigations on the nervous system; was admitted to the Medical Faculty, Paris, in 1860, with a thesis upon secondary pneumonias, and was made one of the physicians at the Salpêtrière; was appointed, in 1867, Professor of Pathological Anatomy; in 1872 was transferred to the chair of Comparative and Experimental Pathology; and in December, 1885, became Dean of the Medical Faculty. As professor he made it a point to perform new experiments in his courses every year. In fact, says Dr. Richet, all his lectures were marked by ingenious views, novel experiments, and important bibliographical data, to such an extent that they could be published as they were, almost without modification; and they constituted excellent monographs.

The anatomy and physiology of the nervous system was his favorite field of research. Next to Claude Bernard, says one of his biographers, he studied with the most particular care, in the minutest details, the nature and functions of the vaso-motor nerves, and the laws of their contractions and dilatations, the general effect of which on the mechanism of the functions is so marked. His lectures on these organs, with those upon the action of toxic substances and medicines, and upon the diseases and physiology of the nervous system, are regarded by Dr. Richet as works of the highest order, which gave definite shape to our knowledge on the most important points, and as containing an "incredible" number of precise facts that have become indispensable to the practitioner. Among these labors, those upon the action of curare, chloral, and strychnine have become classical. The localizations of the functions of the different parts of the cerebro-spinal apparatus, and the effects of alkaloids on these parts, occupied him for a considerable time. He was an eminent physician as well as a skillful physiologist; and in this capacity was called upon to attend, during his last illness, the Comte de Chambord, whose disease baffled the skill of the doctors.

Dr. Charcot, in his funeral eulogy of Vulpian, said that "he might be characterized in a single word—as a man of duty. He was never known to retreat from a task which he had engaged to perform. As soon as he felt his strength declining, he resigned the much-coveted post of physician at the Hôtel-Dieu, five years before reaching the limit of age, and at the same time gave up the civil practice which he had carried on for several years with great success as consulting physician. This was because he wished to employ all of his time in the service of the Academy, and we all know how he discharged his duty in this relation. Vulpian was more than this: he was a man of great and good heart; a man ready to sacrifice everything for his family; a master adored by his pupils; a sure and devoted friend; and I, who have the sad honor of being your speaker, can not recollect without strong emotion how, in the numerous and warm competitions in which we were engaged with one another, Vulpian was always a loyal, generous, and chivalrous rival.

"Although he performed high administrative functions, particularly as Dean of the Faculty of Medicine, he met but few enemies, and these, I believe, belonged to that class of unfortunates who can not come in contact with superiority of heart and mind without having a kind of feeling of irritation and despite. But we may let them pass.

"During the last few years, the condition of Vulpian's health had gradually changed. Then I heard him repeat what he had said to me thirty years before, just after the death of his brother, of whom he was very fond, 'I hope to restore myself by work, a remedy which we are fortunate to have.' Yes, work—always work—was his supreme refuge. The last struggle was one to which he was unequal, but yet we observed him making most courageous efforts to keep himself in the ascendant. He came to the Faculty of Medicine daily with the same order and punctuality that had marked the earlier part of his career, to take up and carry on, as long as his strength permitted him, the lectures which he had conscientiously prepared. At the Institute he performed his difficult duties with that scrupulous zeal and distinction which we have all been pleased to recognize."

M. Vulpian earnestly supported M. Pasteur in his late researches concerning the microbes of infection, and particularly in his investigations and experiments concerning hydrophobia; and when it fell to him to defend the daring inoculator and his intensive system of treatment against attack, he did it in the Academy of Medicine and the Academy of Sciences with a vigor that evoked the applause of the members of both bodies, and silenced M. Pasteur's adversaries for the time. Nevertheless, the intensive treatment has prudently been suspended.

We have been favored with the following grateful reminiscence of Prof. Vulpian by one of his former students, W. W. Skinner, M. D. (Paris), of New York: "It was seven years ago when the pursuit of my medical studies first brought me into contact with this truly great medical teacher. He was then Dean of the École de Médecine of Paris, a position only obtained by the wisest and most learned of the great corps of professors in that school, and which confers upon the incumbent the highest honor that his colleagues can bestow upon him. At the same time, he was Professor of Experimental and Comparative Pathology; and his demonstrations of the pharmacodynamic actions of the most active substances of the materia medica brought a roomful of interested students to his laboratory three times weekly during the summer semester.

"One Tuesday, at the usual hour of his demonstrations in the laboratory, he gave us students an agreeable surprise, and one which we shall long remember. He had invited the renowned Pasteur to show to the class the results of his researches in his now world-famed methods of prophylaxis by vaccination of many virulent diseases of the lower animals. For the short hour of the lecture, Pasteur took chicken-cholera for his subject. He showed the students the micrococcus which causes the disease, the manner of converting it into a harmless vaccinating matter, and finally the lesions produced in the unvaccinated fowl by the micrococcus. Prof. Vulpian, in his large-hearted admiration for his fellow-scientist, took a real pleasure in giving his class an opportunity of seeing and hearing Pasteur.

"The personal appearance of Prof. Vulpian was more than usually striking. He was above the average in stature, and his broad but slightly stooping shoulders were surmounted by a large, finely shaped head, which was adorned by a thick growth of wavy, iron-gray hair. His grave and dignified mien, and the modest air of a true *savant* that he constantly bore, at once commanded the respect and consideration that he so well merited. His kindly disposition of character endeared him to all with whom he came in contact; and the generosity and absence of jealousy with which he welcomed any discovery made by another scientist, or any honor conferred upon a colleague, was another trait in the character of this truly estimable man.

"He lived in the rue Soufflot, that short but fine street in the Latin Quarter of Paris which is closed at one end by the Pantheon, where the remains of Victor Hugo rest, and at the other by the beautiful Jardin du Luxembourg, where stands the stately palace in which the Senate sits. In this remarkable garden of the Luxembourg, full of fountains, statuary, flower-beds, orange-trees, and students, the hero of this sketch was fond of walking after dinner. Almost every evening about sundown he could be seen strolling quietly through the garden, during half an hour, in company with a tall young man whom I supposed to be his son, and with whom he kept up a pleasant, fatherly conversation. Then, before the *retraite* sounded, which was the signal to close the gates, he would return to his home close by, where his arduous professional work awaited him.

"During the progress of that hot debate which took place last year in the French Academy of Medicine upon the value of Pasteur's method of vaccination as a means of preventing the outbreak of hydrophobia after the bite of a mad animal, Prof. Vulpian gave proof of his excellent judgment in medical controversy, and of his unshaken friendship for Pasteur. In the session of January 18, 1887, he made a warm defense of Pasteur's method, and, in closing, used these memorable words: 'The glory of Monsieur Pasteur is such that many envious teeth will be broken upon it. Our works and our names will long be buried under the inconstant tide of oblivion, when the name and the works of Pasteur will still be resplendent, and will shine upon such elevated heights that they will never be reached by that dismal flood.'

"Four months after the utterance of these enthusiastic and prophetic words, Prof. Vulpian was borne to the grave. The members of the Academy of Medicine, the Academy of Sciences, the Faculty of Medicine, and the numerous scientific societies of Paris, participated in the grand and imposing obsequies with which the world-renowned *savant* was honored, and delegates from these institutions pronounced well-merited eulogies over his tomb. The numerous writings from his pen with which medical literature has been enriched will long constitute the highest authority upon the subjects which he investigated."

Vulpian was elected to the Academy of Sciences in the Section of Medicine, when he took the place of Andral in 1876; in 1886 he was chosen perpetual secretary, to succeed M. Jamin. He was given the Cross of the Legion of Honor in 1869, and was made an officer of that body in 1878.

The collection of M. Vulpian's publications gives only an incomplete idea of his labors, which were divided between experimental research and teaching. These works include "Des Pneumonies Secondaires" ("Of Secondary Pneumonias," 1860); and "Leçons sur la Physiologie Générale et Comparée du Système Nerveux" ("Lessons on the General and Comparative Physiology of the Nervous System"). Before the short illness of which he died, he was giving lectures on the respiratory system, and he was about to publish an important book on the cerebral functions.

It is now manifest, says Prof. Judd, that no classification of geological periods can possibly be of world-wide application; and that "we must be contented to study the past history of each great area of the earth's surface independently, and to wait patiently for the evidence which shall enable us to establish a parallelism between the several records." Moreover, while attention was once predominantly given to marine deposits, "the growth of our knowledge concerning the terrestrial floras and faunas of ancient geological periods . . . has constantly forced upon the minds of many geologists the necessity of a duplicate classification of geological periods, based on the study of marine and terrestrial organisms respectively." One of the greatest sources of danger to the progress of geological knowledge at the present day is the tendency to forget that the geological record, although of enormous value, is exceedingly imperfect, and thus to make too hasty generalizations on insufficient data.

EDITOR'S TABLE.

A TEST OF NATIONAL MORALITY.

THE forgery of documents for the purpose of giving fictitious support to doctrines or to territorial claims was a device not unknown to antiquity; and very severe has been the condemnation bestowed upon it by virtuous moderns. The fame of the "false decretals" still lingers in the world; and respectable citizens of our own favored time and country are found wondering how a high spiritual authority could ever have consented to rest its claims, even partially, upon so thoroughly delusive a foundation. Circumstances, however, as has been wisely remarked, alter cases; and that which was very shocking when resorted to for the establishment of principles in which one does not believe, may assume a very different character when found available for promoting the success of the political party that has the honor of commanding the same individual's vote. The "campaign lie" has long been known as a favorite political weapon; but nowadays political mendacity seems, in a peculiar manner, to affect the ancient trick of forgery. The last two or three presidential elections have each had their distinguishing forgeries; but the one just concluded brought the forger's art into a greater prominence than ever before. Men made lies and loved them; and other men loved to see the lies in circulation; and others loved to delude themselves with the lies so made and circulated; until it really seemed as if, throughout a considerable portion of the community, the one thing that everybody hated and feared was truth.

And we are a Christian nation! We hold our heads very high in the world. Our morality is not like that of the decaying states of the Old World, but of a much superior type. We have no royal courts among us to spread servility and corruption; our working-classes are taught to look down with infinite contempt on the "pauper labor" of even such a country as England; our political institutions give every man an interest in the state; and such government as we have is "of the people, for the people, by the people." The theory of our institutions, indeed, is very fine, but we are constrained to say that the practice is very miserable. To have political power in our hands, and then to resort, on a large scale, to falsehood—deliberate, unblushing, reiterated falsehood—as a means of influencing elections, is about as shameful a thing, in our opinion, as the sun shines upon. But, can a thing be politically shameful and yet not dangerous? Fraud and violence are close companions. A quarrel over marked cards is very apt to be settled with the pistol or the knife; and, some day, if political fraud should happen to be just a little too triumphant, we might find ourselves precipitated into another civil war.

Why have we such tolerance for campaign lies and liars? Why do respectable gentlemen, prominent in church circles, either help in the invention of such lies or smile complacently at their circulation? Why is the national conscience so dead on this subject? Has it anything to do with the fact that as yet the morality of science—the morality that consists in the strenuous pursuit and conscientious utterance of *truth*—is so feebly recognized? We have powerful church organizations; the whole land is honey-combed, we may say, with societies for the promotion of a certain type of conventional moral excellence; but what is being done—this, after all, is the question on which the permanence and prosperity of the republic depend—

what is being done to make honest citizens? We know lots of smooth-spoken individuals who are very scrupulous about various matters—much interested perhaps in Sabbath observance; strongly opposed to certain forms of amusement for the young; grieved, possibly, to think that there are people bad enough to hope for the salvation of unevangelized heathen—there are plenty such; but where are the people who hate a lie when they see one, and that without regard to the question as to whose interest is served by it? Where are the men who do not want sophistries served up to them in their favorite newspaper, and who are at all times willing to allow fair weight to a fair argument? In this wide land there are doubtless many thousands who have not bowed the knee to the Baal of political trickery, and who have not imprisoned their souls in any narrow and arbitrary scheme of moral doctrine; but, compared with other types, these are few in number. We meet the man full of church-taught scrupulosities ten times for once that we meet a thoroughly open-minded, honest man. We meet the man who is terribly afraid of doctrinal errors ten times for once that we meet the man who detests the campaign lie. Now, there is nothing to be said against scrupulosity in conduct, nor in favor of doctrinal errors; but falsehoods, the makers of falsehoods, the willing beneficiaries and condoners of falsehoods, and all who leave out of their scheme of life the duty of opposing falsehoods in all their shapes and guises can not be too strongly condemned.

Where is the remedy for this dangerous national habit of political lying? It is to be sought in a reorganized national education. Instead of filling the minds of children with fables, as to a large extent we do, we need to cultivate in them the sense for reality by teaching them to know things in their properties and relations, and natural processes in their definiteness and certainty. In other words, science has to take hold of education and remodel it, until it gives us a generation of citizens too intelligent and with too practiced a sense for truth to fall the easy prey that so many thousands now do to the arts of the political trickster. One may be excused for doubting whether at this moment the political honesty of our nation is really on the increase; but we shall hope that the time may come before very long when science shall do for politics and for morality what it has done for our knowledge of the physical world and of human nature, and give us a regenerated state, the outcome of an intellectually nobler type of manhood.

WORK AT THE LICK OBSERVATORY.

THE great thirty-six-inch telescope of the Lick Observatory has not only more than satisfied the most confident anticipations of what it would be able to do, it has taken the astronomical world by surprise with its revelations. It is not too much to say that it has opened up new vistas of creation, and given to the eye of man so much wider and deeper a range in the universe that, as Prof. Holden, the director of the observatory, has remarked, when looking through this telescope the observer must view objects as if seen for the first time. Celestial phenomena present an appearance, in many cases, so different from that familiar to observers with less powerful instruments that the impression they make is entirely new.

Of course, primarily, the great size and exquisite figuring of the giant object-glass must have the credit for all this, and yet much (very much more, probably, than the general public imagine) is due to the director and his able assistants. Prof. Holden has applied the unrivaled equipment of Mount Hamilton Observatory to the observation of the heavens in a broad-minded way that is decidedly refreshing and encouraging by contrast with the manner in which the powers of some great telescopes have been misapplied and frittered away. There are some astronomers who seem to be fearful of nothing so much as that they may be suspected of having done, or said, or seen something interesting. Prof. Holden does not belong in that category, and it is exceedingly gratifying to know that the most powerful telescope on our planet is in the hands of a man who will use it for the broadening of our knowledge of the universe, even at the risk of contributing to the fund of "popular" information.

The discoveries that Prof. Holden has already announced to the world, in the few months since the Lick telescope was first turned upon the sky, are of surpassing interest. We note first the observations of nebulæ, and particularly of the well-known "ring nebula" in Lyra, one of the most attractive of celestial objects even with a telescope of moderate size. In that singular creation Prof. Holden has discovered a marvelous coexistence of rings of stars and nebular ovals, evidently intimately related to one another in a manner that is in the highest degree significant. Then, too, in the nebula known as 37 II 4 in the constellation Draco, Prof. Holden and one of his assistants, Mr. Schaeberle, appear to have discovered a phenomenon of an entirely new order. There a central star is surrounded by ovals of nebular matter which have assumed the form of a helix, and Prof. Holden himself suggests that this spiral or screw-shaped formation appears to have resulted from the emanation of the nebulous stuff from a body that was revolving around the central star while that star itself was moving swiftly through space. His observations promise to make us acquainted with other objects belonging to this same mysterious class.

The director of the Lick Observatory has not scorned to apply its powers to the scrutiny of the well-worn and familiar features of the dead and barren moon, and there too he has found something new and interesting. He believes he has solved the mystery of Sir William Herschel's lunar volcanoes, which that great observer imagined he had actually beheld in fiery eruption.

Some of the most interesting astronomical discoveries of recent years relate to the planet Mars, and foremost are the observations of Schiaparelli, of Milan, on those curious features of the planet's disk which have been called, from their form and their apparent connection with the Martian seas, "canals." Last summer Perrotin, of Nice, announced that one of the Martian continents named Libya had apparently been inundated by a neighboring sea. Not a few astronomers have doubted the existence of these comparatively minute markings and changes upon Mars, because they could not see them themselves. But Prof. Holden and his assistants turned the monster telescope upon Mars with the most interesting results. They confirmed the existence of Schiaparelli's "canals," though they did not see any of them double (doubtless owing to unfavorable conditions), and they found that Libya was still there, unsubmerged. These observations were made some months after those of M. Perrotin; and Prof. Holden suggests that the partial disappearance of Libya, which Perrotin ascribed to an inundation, may have been due rather to some such phenomenon as a veil of clouds in the atmosphere of Mars. At any rate, what were supposed to be such cloud-masses have previously been observed on Mars.

We have called attention to these various observations in order to show in what manner the Lick telescope is being used, as well as to indicate briefly some of the results already attained. We congratulate Prof. Holden and the University of California upon the splendid success of this great astronomical enterprise. The spirit of James Lick, if it can comprehend terrestrial doings while his body lies under the pier of the great telescope, must be moved with gratification at the complete fulfillment of his desire to build a telescope that should surpass all others in its achievements.

LITERARY NOTICES.

On the Senses, Instincts, and Intelligence of Animals: with Special Reference to Insects. "International Scientific Series," Vol. LXIV. By Sir John Lubbock, Bart., M. P., F. R. S. New York: D. Appleton & Co. Pp. 292. Price, $1.75.

The name of Lubbock will cause the reader to open this volume with an eager interest that will be amply justified. It is an extension of the investigations recorded by the author in his fascinating work on "Ants, Bees, and Wasps," going further into details of structure and function of the sense-organs of insects, together with some discussion of the intelligence displayed by higher animals. In the first half of the book, he gives us the results of his own observations, combined with what other investigators have learned as to the location of each sense in insects, and the structure of the organs in which each resides. He explains the purpose of this part of the work as follows: "While attempting to understand the manners and customs, habits and behavior of animals, as well as for the purpose of devising test experiments, I have found it necessary to make myself acquainted, as far as possible, with the mechanism of the senses, and the organs by means of which sensations are transmitted. With this object I had to look up a great number of memoirs, in various languages, and scattered through many different periodicals; and it seemed to me that it might be interesting, and save others some of the labor I had to undergo myself, if I were to bring together the notes I had made, and give a list of the principal memoirs consulted. I have accordingly attempted to give, very briefly, some idea of the organs of sense, commencing in each case with those of man himself." The list of memoirs to which he alludes is an extended one, occupying eight pages. He begins his descriptions with the sense of touch, "as being the one which is most generally distributed, and from which the others appear to have been in some cases developed. The senses are not, indeed, as already mentioned, always to be easily distinguished from one another; and it would seem that the same nerve may be capable of carrying different sensations according to the structure of the end organs." The inner skin of insects and crustaceans being covered with a layer of horny substance, the sensations of insects, excepting sight, are transmitted by means of hairs projecting through this hard integument. The organs of taste in insects are certain modified hairs situated either in the mouth itself, or on organs immediately surrounding it. Experiments which have been made seem to prove that the sense of smell resides partly in the antennæ and partly in the palpi. "This distribution would be manifestly advantageous. The palpi are more suited for the examination of food; while the antennæ are more conveniently situated for the perception of more distant objects." The antennæ probably serve partly as organs of touch, and some as organs of protection. The author deems it very probable also that some of them, at least, perform still another function, such as hearing, "while some of these peculiar antennal organs," he says, "though obviously organs of sense, seem to have no special adaptation to any sense of which we are cognizant." That insects may have senses of which we are not cognizant, he deems very probable. There are, without doubt, causes in nature which would produce sensations different from any we know of on organs capable of receiving them. For instance, Sir John has shown elsewhere that animals hear sounds which are beyond the range of our hearing, and can perceive the ultra-violet rays, which are invisible to our eyes. Sound and light are both produced by vibrations. The shrillest sound audible to us results from forty thousand vibrations a second, and no light that we can see is produced by less than four hundred million millions of vibrations in a second. "But between forty thousand vibrations in a second and four hundred million millions we have no organ of sense capable of receiving the impression. Yet between these limits any number of sensations may exist. We have five senses, and sometimes fancy that no others are possible. But it is obvious that we can not measure the infinite by our own narrow limitations. Moreover, looking at the question from the other side, we find in animals complex organs of sense, richly supplied with nerves, but the function of which we are as yet powerless to explain. There may be fifty other senses as different from ours as sound is from sight." It has been thought that the antennæ in all insects are the organs of hearing, but it has since been shown that the sense of hearing is not confined to one spot, and indeed there is no reason why it should be. Grasshoppers and crickets have ears on their legs, and the crustacean genus *Mysis* has ears in its tail. Organs of sight, which are the most complex and varied of sense-organs, are treated in this book at greatest length. In regard to the mode of vision by means of compound eyes, the author supports Müller's view that "the picture perceived by the insect will be a mosaic, in which the number of points will correspond with the number of facets." Two interesting chapters are those in which he describes an extension of his earlier experiments on the power of bees and ants to distinguish colors, and answers the objection that the power which he ascribes to ants of perceiving the ultra-violet rays is not true sight, but a sensitiveness of the skin to light. Recognition among ants he believes is effected to a great extent by the antennæ, whether or not smell is the sense which serves for this purpose. Along with some extraordinary manifestations of intelligence in insects, he tells of some interesting cases of apparent stupidity observed by him and by M. Fabre. The closing chapter is on the intelligence of the dog, and is occupied mainly with an account of Sir John's application to his black poodle "Van" of the method used in teaching Laura Bridgman. The poodle apparently learned to bring a card marked "food," "out," "bone," "tea," etc., according to his wants, but when a card of a particular color, or having one, two, or three dark bands on it, was held up to him, and he was sent to fetch a duplicate from among several cards, he generally failed. The author also discusses briefly the question, "Can animals count?" but has reached no definite conclusion on this point. The mental faculties of man and the lower animals are now being investigated as never before. The problems relating to these faculties are being attacked from many different sides, and while much valuable knowledge is resulting from these labors, a great deal of careless observation, unjustified assumption, and baseless theory is being put forth at the same time. Sir John Lubbock, however, is a careful and patient experimenter and a cautious reasoner, and on every page of his writings he shows that his object is the attainment of truth, and not the defense of pet theories.

Darwinism. By David Starr Jordan, Ph. D. Chicago: A. B. Gehman & Co. Pp. 63. Price, 25 cents.

Every one who has read any of President Jordan's popular articles on scientific subjects will want a copy of this essay. In it he sets forth, with his well-known vigor and captivating clearness, the main features of the Darwinian theory of the origin of species, and gives samples of the evidence on which this theory rests. He begins by alluding to the variety of the forms of life on the earth, and then calls attention to the unity which exists in this diversity. For instance, "there are dogs and dogs, of all sizes and styles, yet enough alike for us to regard them as belonging to one original species." Then there are other dog-like animals—wolves, coyotes, jackals, foxes—which we must regard as first-cousins to the dogs. Each of these races has still other relatives, further removed from the dog-type, and, proceeding thus, we have at last all animals of the mammalian class "joined together by a branching chain of apparent relationship—a chain of homologies." The problem before us is, "What is the origin of variety in life, and how does it come that this variety is based on essential unity?" The author then reviews the answers which have been given to this problem by Linnæus, Cuvier, Lamarck, Saint-Hilaire, Goethe, and Agassiz. Darwin's answer to the problem follows, and is stated partly in quotations from his works and his letters, and is supplemented by illustrative cases by the author. How Darwinism explains the facts of geological distribution, and of degeneration both of type and of individual parts in the organism, is next explained, and a brief account of the evidence which embryology brings to the support of the theory of evolution, contributed by Dr. J. S. Kingsley, is here inserted.

"The various attacks on the theory of descent," says President Jordan, "have nearly all centered on the question of the origin of man." But these attacks are wholly unreasonable. "Our objections to recognizing our kinship with the lower forms—if we have any such objections—rest on reasons outside the domain of knowledge. They do not rest on religious grounds. . . . Looking over the history of human thought, we see the attempt to fasten to Christianity each decaying belief in science. That the earth is round, that it moves about the sun, that it is old, that granite ever was melted—all these beliefs, now part of our common knowledge, have been declared contrary to religion; and Christian men who knew these things to be true have suffered all manner of evil for their sake." A short sketch of the life of Darwin is prefixed to the essay.

Researches on Diamagnetism and Magne-Crystallic Action. By John Tyndall, D. C. L., LL. D., F. R. S. New York: D. Appleton & Co. Pp. 288. Price, $1.50.

The researches embodied in this volume cover the first six years of Prof. Tyndall's experimental work. The first investigation of the series treats of the deportment of crystals, and of other bodies possessing a definite structure, in the magnetic field. Plücker had discovered that deportment, and had attempted to account for it by supposing new forces and new laws. Faraday followed and corroborated Plücker, and added one more hypothetical force. These forces were held to be wholly distinct from magnetism and diamagnetism. Tyndall and Knoblauch found a much simpler way of accounting for the phenomena observed, which, in place of the assumption of three new forces, required only a simple modification of known forces, to which they gave the name elective polarity. Prof. Tyndall's first investigation on the subject of diamagnetic polarity is described in the "Third Memoir" of this volume. Supplied with more adequate apparatus and material, he prosecuted the research as recorded in the "Fourth Memoir," subjecting the deportment of diamagnetic bodies to an exhaustive comparison with that of magnetic bodies, which showed that the diamagnetic force had the same claim to be called a polar force as the magnetic. In the "Fifth Memoir" are described experiments made with a very delicate apparatus, which proved that the theory of diamagnetic polarity would stand the severest tests. The application of the doctrine of polarity to magne-crystallic phenomena is the subject of the "Sixth Memoir." Appended to these papers are letters by Weber, Faraday, and Tyndall, relating to the investigations, together with some brief descriptions of apparatus.

Journal of Morphology. Vol. II, No. 1. Boston: Ginn & Co. Pp. 190.

This number of the "Journal" contains five papers. The first is a brief account of "Observations on the Structure of the Gustatory Organs of the Bat (*Vespertilio subulatus*)," by Frederick Tuckerman, M. D. This is followed by a paper by Prof. E. D. Cope, "On the Tritubercular Molar in Human Dentition." Prof. Cope has investigated the variation in the number of tubercles forming the crown of the superior true molars in man, and has concluded that "the quadritubercular type of molar crown, illustrated by the first superior true molar of man, belongs to the primitive form from which all the crest-crowned (lophodont) molars of the hoofed placental mammals have been derived; and second, this quadritubercular type of molar has itself been derived from a still earlier tritubercular crown by the addition of a cusp at the posterior internal part of it." He says, further, that "the tritubercular superior molars of man constitute a reversion to the dentition of the *Lemuridæ* of the Eocene period of the family of *Anaptomorphidæ;* and, second, that this reversion is principally seen among the Eskimos, and the Slavic, French, and American branches of the European race." In the lowest existing races the quadritubercular type predominates, while the neolithic dentitions examined are of an intermediate character, thus showing a superior position to these races. The third paper is by C. O. Whitman, on "The Seat of Formative and Regenerative Energy," and deals with the question whether the cytoplasm is a passive body, moving only as it is acted upon by external forces and influences emanating from the nucleus, or whether it has powers of its own which make it capable also of automatic action. Prof. Henry F. Osborn presents "A Contribution to the Internal Structure of the Amphibian Brain," in which are reported certain studies of nerve-fiber courses and determinations of motor and sensory nuclei. Dr. William Patten contributes a second installment of his "Studies on the Eyes of Arthropods," devoted to the eyes of Acilius. Thirteen plates accompany this number.

Index to the Literature of the Spectroscope. By Alfred Tuckerman, Ph. D. Washington: Smithsonian Institution. Pp. 423.

The literature of science is becoming so voluminous that classified indexes are absolutely essential to the student who would obtain an adequate idea of what is going on in his specialty. This index, in its own fullness, illustrates the fact. It is intended to be a bibliography of the spectroscope and spectrum analysis, and to be a list of all the books and smaller treatises, especially contributions to scientific periodicals, from the beginning of our knowledge on the subject till July, 1887. The time covered by this description is not very great, but the number and variety of the titles recorded show how incessant has been the activity of research during the period. An admirable system of arrangement is adopted, under which a strictly alphabetical order of the subjects is followed. Titles have often been repeated more than once, so as to make sure of their being found, and a list of authors is added.

Essays on Practical Politics. By Theodore Roosevelt. New York: G. P. Putnam's Sons. Pp. 74. Price, 40 cents.

The two essays comprised in this volume have appeared in "The Century," and are now reprinted in the "Questions of the Day" series. Prefixed to them is an introduction, in which the author replies to the criticism made at the first appearance of his essays, that they offer no cure for the evils they portray, by saying that he attempted only to make a diagnosis of the disease, and not to prescribe for it. He says further that, just as many sick men demand a pleasant medicine which will cure all their complaints without their making any change in their work or pleasure, or their eating and drinking, so certain other men "expect some scheme of reform that will at a single fell swoop do away with every evil from which the body politic is suffering. . . . No law or laws," he continues, "can give us good government; at the utmost, they can only give us the opportunity to ourselves get good government." He then specifies several things that good citizens ought to work for, and says, "Above all, we can strive to fulfill our own political duties, as they arise, and thereby to do each of us his part in raising to a healthier level the moral standard of the whole community." The first of the essays is on "Phases of State Legislation," and is based mainly on Mr. Roosevelt's experience as a member for three terms of the New York Legislature. It reveals a great deal of viciousness and weakness, and also gives credit for a great deal of good work. It contains, too, a number of very amusing incidents. The other essay describes "Machine Politics in New York City," and deals with not only the methods of the men who run politics for the benefit of themselves and their followers, but also the neglect of public duties by respectable men, which makes the doings of political jobbers possible.

Manual of Chemistry. By W. Simon, Ph. D., M. D. Second edition. Philadelphia: Lea Brothers & Co. Pp. 479.

The present edition of this manual, while retaining the general character of the first, embodies also a considerable number of changes and additions. The work is specially adapted for students of pharmacy and medicine. It assumes no previous knowledge of chemistry, and hence may be called a text-book for beginners, though it is not suited to the needs of young pupils. The first twenty pages are devoted to a brief consideration of the fundamental properties of matter, and are followed by thirty pages on the principles of chemistry. The author is in the habit of scattering these principles along through his course of lectures, but in a text-book to accompany the lectures he prefers to collect them in one place. The third and fourth parts of the volume are devoted respectively to the consideration of the non-metallic and the metallic elements and their compounds. Only those elements are taken up which have a practical interest, and for the special benefit of pharmaceutical and medical students space is given to all chemicals mentioned in the "United States Pharmacopœia." The fifth part deals with qualitative analysis, including also a chapter giving the principal methods for volumetric determinations. Organic chemistry occupies a little over one fourth of the volume, and in this department special prominence is given to those substances most important in medicine and pharmacy. In the closing part physiological chemistry is treated, including a consideration of the chemical changes which take place in animals and plants, and of the chemical composition of animal fluids and tissues, with full directions for testing urine. A notable feature of the book is seven plates showing the colors of fifty-six precipitates and liquids, which beginners often have difficulty in becoming familiar with. There are also forty-four cuts representing apparatus.

A Synopsis of the Medical Botany of the United States. By J. M. G. Carter, M. D., Ph. D. St. Louis: George H. Field. Pp. 176. Price, $2.

Dr. Carter has accomplished a laborious service for the physicians of the United States. The book consists of a list of the species under each genus which are known to be useful in medicine, giving their medicinal properties, and telling what parts of the plant are used, and the dose. The medicinal plants of the United States embrace about 140 orders, 620 genera, and more than 1,300 species and varieties. The botanical arrangement is chiefly that of Dr. Asa Gray. The names of introduced species are distinguished by small capitals, and the habitat of rare plants is given. The volume is supplied with a table of orders, and indexes of generic names and of common names of plants, and an index of diseases.

The Journal of Physiology, Vol. IX, Nos. 2 and 3 (Cambridge (England) Scientific Instrument Company) contains eight papers giving the results of laboratory investigations. The first is "On the Physiology of the Salivary Secretion," by J. N. Langley, of Cambridge, and records experiments made to determine whether the "trophic" and "anabolic" fibers of the secretory nerves are paralyzed by atropine at the same time as the "secretory" fibers. This is followed by a paper on "The Physiological Action of Borneol," by Ralph Stockman, M. D., of Edinburgh, and "A Note on the Cause of the Failure of very Rapid Electrical Stimulation to produce Tetanus in Muscle," by Henry Sewall, of Ann Arbor, Mich. "An Experimental Investigation of Strychnine-Poisoning" is contributed by Robert W. Lovett, M. D., of Boston, who concludes that the spinal cord, upon which strychnine exercises peculiar power, takes up more of the drug than the other organs; but whether or not it is more susceptible to the drug than the other organs we have no means of ascertaining. The next paper is "On the Circumstances which modify the Action of Caffeine and Theine upon Voluntary Muscle," by T. Lauder Brunton and J. Theodore Cash; this is followed by a report of an investigation "On the Electrical Organ of the Skate," by J. Burdon-Sanderson and Francis Gotch. The remaining papers are "On the Rhythm of the Mammalian Heart," by John A. McWilliam, M. D., of Aberdeen, illustrated by plates of tracings; and "Further Researches on the Apparent Change produced by Stimulation in the Polarization of Nerve," by George N. Stewart, of Manchester.

Prof. *E. D. Cope* read before the American Philosophical Society in January last a paper entitled *Synopsis of the Vertebrate Fauna of the Puerco Series*. The Puerco formation rests on the Laramie in northwestern New Mexico and southwestern Colorado, and was discovered by Prof. Cope in 1874, and vertebrate remains were found in it by Mr. David Baldwin in 1880. One hundred and six vertebrate species have been found so far, which differ so much from the fauna which preceded and followed them, as to show that this formation represents an immense interval that had not been previously suspected. These species are described in the present paper, and the descriptions are illustrated by two plates, and by cuts showing dentition.

University Studies is the name of a periodical published by the University of Nebraska, at Lincoln, the first number of which, dated July, 1888, is before us. The price of a single number is $1; yearly subscription, $3. There is no announcement of the purpose or times of publication of the journal in this number. Its contents comprise three papers: "On the Transparency of the Ether," by D. B. Brace; "On the Propriety of Retaining the Eighth Verb-Class in Sanscrit," by A. H. Edgren; and "On the History of the Auxiliary Verbs in the Romance Languages," by J. A. Fontaine. The first paper is an investigation of the phenomena which would occur if there were any absorption of the light-energy of stars by the ether, through frictional forces or imperfect elasticity. The result of the author's calculations is, that the apparent finiteness of the stellar universe can not be due to absorption, as Struve supposed; and that, if the universe is infinite in extent, "the average density of distribution of self-luminous bodies outside our own system must be exceedingly small, as otherwise the sky would appear of a uniform brightness, approximating that of the sun."

In his *Annual Report of the Division of Forestry for* 1887, the chief, Mr. *B. E. Fernow*, defines the work of the division as in the main that of a bureau of information. During the past year the division has distributed different circulars of information to wood-consumers in general, to railroad managers, to educational men, and to members of the National Grange. These, together with a letter to the Commissioner of the Land-Office on what is a timber-tree, are reproduced in full or in substance in the report. The pamphlet also contains statistics in regard to exports and imports of wood and wood products, from 1880 to 1887, and the mill capacity of the country. Seeds and seedlings, mainly of cone-bearing trees and willows, have been distributed to some extent. Mr. Fernow thinks it is time for the division to undertake systematic original investigations. The scientific basis of forest management must be built up from researches in forest biology, timber physics, soil physics, and soil chemistry; its economic basis will consist of forest statistics, technology of woods, and forest policy; and its practical basis will comprise knowledge of methods of planting, managing, and harvesting forests. The report contains notes on certain species of trees, the seed of which has been distributed from the department during the season, telling their value and the mode of their propagation. These notes are followed by statements of the condition of the forestry interests in the several States and Territories.

The Tōyō Gakugei Zasshi ("Eastern Science Journal"), in Japanese, is edited by a committee consisting chiefly of professors in the Imperial University at Tokio, Japan, and has the large circulation, for a country like Japan, of three thousand copies. The number which has been sent to us as a specimen has articles on the primeval world of Japan (accompanied by illustrations of Japanese geology), the aborigines of Japan, the submarine world, "A Great Eastern Problem," and "The Standard Time of Japan," with notes and miscellanies on various subjects, and reviews of books.

The Kitchen, a Magazine devoted to Scientific Cookery in all its Branches (J. H. Lewis, publisher, Chicago), is a monthly magazine devoted to what the publisher justly considers the central and predominant interest of all housekeeping. Subjects pertaining to cookery are presented in an untechnical, common-sense style, and occupy about half of each number. The rest of the space is devoted to matters of different character, the object seeming to be, besides cultivating well the special field of the periodical, to furnish a variety of reading, and make it attractive in other directions. Price, 20 cents each number; $2 a year.

The character of *Chemical Experiments for Medical Students*, by *W. S. Christopher*, M. D. (R. Clarke, $1), has been conformed to the limited time allowed for the study of chemistry in most medical schools. Hence it includes only such methods and facts as the student will need to use in the practice of his profession. It is a laboratory manual, the experiments covering work with the principal metals and acids, using Beilstein's examples. In addition, the more important alkaloids and some organic compounds of medical interest are considered. In physiological chemistry the work deals with the proteids and carbohydrates, the digestive processes, blood, bile, milk, and urine. The acid tests recently introduced for the clinical examination of stomach contents are also given. It is intended to be used with some systematic treatise on chemistry.

We have received from Thomas Prosser & Son, the New York agents of Friedrich

Krupp, a volume entitled *Krupp and De Bange*, by *E. Monthaye*, captain in the Belgian general staff. Its object is to show that the Krupp system of ordnance is superior to the De Bange system, from which it differs in material, construction, and mode of breech-closure. The first chapter is a discussion of various methods of preparing steel for gun-metal; the second compares the construction of the Krupp and the De Bange guns; this is followed by an essay on ballistic performance, and a statement of the extent to which the European states use the Krupp guns. The next chapter answers the objections of the adherents of the French gun against the Krupp, and there is a review of the "Belgrade competition" of 1884, in which a Krupp, a De Bange, and an Armstrong gun participated. An account of a visit to the Krupp works concludes the main part of the book, and to this is appended an analysis by another hand of some criticisms made upon Captain Monthaye's book. The volume is illustrated with diagrams, views, and a portrait of Alfred Krupp.

A decidedly vigorous pamphlet has been contributed to the "Questions of the Day" series, by Mr. *J. S. Moore*, entitled *Friendly Letters to American Farmers and Others* (Putnam, 25 cents). Its purpose is to show the people of the country, regarded as consumers, what the present tariff costs them. The letters are strengthened by abundant statistics, and the following specimen headings will indicate their character: "What it costs the Farmer for Lumber," "What it costs the Farmer for Crockery, Glassware, and Cooking Utensils," "Female Labor on Farms and in Factories," "As to Luxuries and Necessities," and "The Champion Tariff Swindle of the World."

The subject of the next number of the "Questions of the Day" series is *American Prisons in the Tenth United States Census* (Putnam, 25 cents). It is by *Frederick H. Wines*, special agent of the tenth census, and presents the numbers of inmates in the prisons of the country, and the crimes for which they are imprisoned, in a great variety of aspects, such as with regard to birthplace, age, sex, color, length of term, and number of arrests by the police. The figures are embodied in a discussion which includes suggestions for the improvement of certain State and national prison laws. An interesting statement, which reverses the popular judgment somewhat, shows the proportion of prisoners to the number of residents from each of twenty foreign countries. From this it appears that the West Indies send us the most criminals, 1 in 117, while the best showing is made by the Austrians (including Hungarians and Bohemians), 1 in 1,936. The Scandinavians stand next to the Austrians, and the Hollanders are third. The Germans are eighth, with one prisoner in 949 German-born residents, the English eleventh, French twelfth, Irish fourteenth, 1 in 350, Italians sixteenth, and Chinese next below them, with a proportion of 1 in 199.

Two editions of the *President's Message* of 1887 (Putnam, each 25 cents) have been received. One contains annotations by *R. R. Bowker*, which embrace a large number and variety of facts and figures showing the receipts and expenses of the Government for a number of years, the effects of buying bonds at a premium, what the tariff tax amounts to on many items of the consumer's purchases, the percentages of tax laid on important articles at various times since 1789, the variation of wages in Europe and different parts of this country, the amount of wool raised in the United States, the operations of trusts, etc. The other edition is illustrated by Thomas Nast, in his well-known style.

The most extended and important papers in *Reports from the Consuls of the United States*, No. 93 (Department of State), are those on "The Cost of Manufacturing Print-Cloths in Massachusetts, Lancashire, and Switzerland," by J. Schoenhof; "The Province of Kiang-su," by J. D. Kennedy; "The Exhibition for the Prevention of Accidents to be held at Berlin in 1889," by F. Raine; "The Trade of South America," by John E. Bacon; "The Trade and Industries of Russia," by Charlton H. Way; and "The Resources and Trade Relations of Japan," by T. R. Jernigan.

The pamphlet on *Aspects of Education*, by *Oscar Browning* (Industrial Education Association, 20 cents), is a contribution to the history of pedagogy. It discusses the three modifications of educational theory—humanism, realism, and naturalism—to one or another of which all schemes of instruction that have taken practical form in the last three hundred years may be referred. The essay includes also some remarks on the English public school.

The children will be sure to like *The New Model First Reader* (Sherwood, 35 cents) for its colored pictures, which are supplied with a liberal hand. The mode of teaching to which it is adapted is that known as the sentence-method. It familiarizes the pupil with script as well as with Roman letters.

PUBLICATIONS RECEIVED.

Academy of Natural Sciences of Philadelphia. Proceedings continued. Pp. 24.

Allen, John H. The Tariff and its Evils. New York: G. P. Putnam's Sons. Pp. 122. $1.

Bain, Alexander. English Composition and Rhetoric. Enlarged edition. Part II. Emotional Qualities of Style. New York: D. Appleton & Co. Pp. 325. $1.40.

Baker, Henry B., M. D., Lansing, Mich. The Causation of Cold-Weather Diseases. Pp. 15.—Recent Advances in State Medicine. Pp. 27. The Prevention of the Communicable Diseases. Pp. 7.

Barton, Samuel. The Battle of the Swash and the Capture of Canada. New York: Charles T. Dillingham. Pp. 131. 50 cents.

Berger, François. French Conversations—Idiomatic Expressions—Proverbs. 853 Broadway, New York. Pp. 32. 25 cents.

Brandt, Prof. H. C. G., Hamilton College. Should the Elements of French and German be required for Admission to all Colleges? Pp. 8.—A First Book in German. Boston: Allyn & Bacon. Pp. 87. $1.

Browning, T. B., Toronto. Chart of Elocutionary Drill. Pp. 33.

Calkins, Mary Whiton. Sharing the Profits. Boston: Ginn & Co. Pp. 70.

Cameron, James. Soaps and Candles. Philadelphia: P. Blakiston, Son & Co. Pp. 306. $2 25.

Clokey, Rev. Joseph Waddell. Dying at the Top. Chicago: Woman's Temperance Publishing Association. Pp. 56. 10 cents.

Cope, E. D. Topinard on the Latest Steps in the Genealogy of Man. Pp. 4.

Crozier, John Beattie. Civilization and Progress. London: Longmans & Co. Pp. 447.

Cruger, Mary. How she did it: or Comfort on $150 a Year. New York: D. Appleton & Co. Pp. 212.

Dawson, Sir J. William. Specimens of Eozoon Canadense and their Geological and other Relations. Montreal: Dawson Brothers. Pp. 107. 50 cents.

Evans, George. A Hand-Book of Historical and Geographical Phthisiology. New York: D. Appleton & Co. Pp. 295. $2.

Fletcher, W. Q. "The Co-operative Index to Periodicals." Quarterly. Vol. IV, No. 3. 330 Pearl Street, New York. Pp. 29. 50 cents. $2 a year.

Frieze, Henry S. The Tenth and Twelfth Books of the Institutes of Quintilian, with Explanatory Notes. New York: D. Appleton & Co. Pp. 294. $1.40.

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POPULAR MISCELLANY.

The International Geological Congress.—The fourth session of the International Geological Congress was held in London, beginning September 16th, under the presidency of Prof. Prestwich. The United States was represented in the list of vice-presidents by Prof. Frazer, of Philadelphia. The meeting was the largest in attendance, both of home and foreign geologists, that has been held. It differed from the previous meetings in the point that no votes were taken bearing upon the subjects under discussion; but a report was adopted recommending that in future the members from the country in which the Congress meets shall vote separately from the foreign geologists: if the two groups agree, the question to be considered settled; if not, deferred; and that votes should not be taken on questions that are purely theoretical. The classification of the Cambrian and Silurian strata was fully discussed, and the questions of the nature and origin of the crystalline schists, and of the upper limit of the Tertiary system, were considered in some detail. To the second discussion essays were contributed by five officers of the United States Geological Survey, with an introduction by Major Powell, and by Mr. Lawson, of Canada. The committee on nomenclature and classification has obtained reports from the committees of the different countries, embodying their views on the subject. It now remains to discuss these. Another commission was appointed under the new aspect of the subject, on which Prof. Hall represents the United States. Four or five sheets of the geological map of Europe, relating to central Europe, will be ready for publication within the next two years, and will be given out at once, each with its own title and index, without waiting for the completion of the whole. The Congress decided to hold its fifth meeting, in 1891, in Philadelphia; and Messrs. J. Hall, Dana, Newberry, Frazer, Gilbert, Hunt, Marsh, and Walcott were appointed the committee of arrangements.

Interglacial Man in Ohio.—Until recently it has been a question whether "interglacial" man existed in the Mississippi Valley. Dr. Abbott had even made the suggestion that this race may have lived only in the neighborhood of the sea-coast, and had not spread so far as even to the eastern slope of the Alleghanies. Flint implements palæolithic in character were found in abundance—the work of Indians—but none that could be proved to be of palæolithic age. Some three years ago, however, genuine palæolithic flints were found by Dr. Metz at Madisonville and Loveland, Ohio. The sites of these discoveries have been carefully examined by the Rev. G. F. Wright, who, taking the whole configuration and geological character of the region, with its peculiar formations, into account, pronounces the beds to be unquestionably virgin glacial deposits, in situations where there can have been no subsequent deposition. The discoveries, therefore, show that in Ohio, as well as on the Atlantic coast, man was an inhabitant before the close of the glacial period. A discovery of implements of quartz, situated likewise in gravels and sands that could only be glacial, made by Miss Babbitt at Little Falls, Minn., is confirmed by the researches of Mr. Warren Upham.

Our Indians and the Mongolians.—Dr. Brinton, in a paper read at the American Association, maintained that the resemblances alleged by various writers to exist in language, culture, and physical appearance between American Indians and Mongolians are not supported by recent researches. The

American languages differ entirely from any of the Mongolian group. In culture there are various similarities, but not more and not other than can be pointed out between any two groups of early civilizations, and not one of them is evidence of intercourse. The physical similarities relied upon to show racial affinity begin with the color of the skin. But no American tribe shows the peculiar hue of the Mongol. The hair, although straight in both races, differs in color. The oblique, or Chinese eye, about which much has been said, is by no means usual in the American race, scarcely more so than among the whites, and is, moreover, of less importance than has been maintained. The shape of the skull is markedly different. The Mongolian head is round, that of the Eskimo notably long, and of other tribes mixed. The nasal index of the American Indian approaches that of the modern European much closer than it does the Mongolian. There are in certain tribes some general physiognomical characteristics, and that is all—and this is of little importance.

Religious Notions of Gypsies.—The gypsies' religion, says the author of "The Transylvanian Tziganes," in "Blackwood's Magazine," is of the vaguest description. They generally agree as to the existence of a God, but it is a God whom they can fear without loving. "God can not be good," they argue, "else he would not make us die." The devil they also believe in to a certain extent; but only as a weak, silly fellow, incapable of doing much harm. A gypsy, questioned as to whether he believed in the immortality of the soul and the resurrection of the body, scoffed at the idea. "How could I be so foolish as to believe this?" he asked, with unconscious philosophy. "We have been quite wretched enough, and wicked enough, in this world already. Why should we begin again in another?" Sometimes their confused notions of Christianity take the shape of believing in a God, and in his Son, the young God; but while many are of the opinion that the old God is dead, and that his Son now reigns in his place, others declare that the old God is not really dead, but has merely abdicated in favor of the young God. Though rarely believing in the immortality of the soul, the Tzigane usually holds with the doctrine of transmigration, and often supposes the spirit of some particular gypsy to have passed into a bat or a bird; further believing that, when that animal is killed, the spirit passes back to another new-born gypsy. The gypsies resident in villages and hamlets often nominally adopt the religion of the proprietor of the soil, principally, it seems, in order to secure the privilege of being buried at his expense.

Effects of Cigarette-Smoking.—During a discussion in the American Association, Prof. W. S. Dudley described some experiments which he had made on the injurious effects of cigarette-smoking. He showed that they were principally due to the manner of smoking, and not to the impurities, as is currently supposed. In smoking cigarettes, to get the desired effect, the smoke is inhaled, that is to say it is breathed into the lungs; whereas, in smoking pipes and cigars, the smoke is simply drawn into the mouth and then expelled. In experiments on small animals, in which they were caused to breathe air containing cigarette-smoke, it was found that, after a mouse had smoked one and a fourth cigarette life was extinct. Examination of its blood showed that it had died from the effects of the carbon monoxide which was contained in the smoke, and not from the nicotine and other volatile products of the tobacco and paper. This carbon monoxide is produced by the carbonic-acid gas, which is first formed at the end of the lighted cigarette, passing through the red-hot carbon, while the air is excluded. The smoke of a cigar or pipe, or a Turkish water-pipe, would have the same effect if inhaled.

Development of the Plesiosaurus.—Prof. H. G. Seeley exhibited in the British Association last year a remarkable fossil showing the development of the young of the plesiosaurus. Until this fossil had been discovered and forwarded to him, he had sought throughout the collections of Europe for evidence on that development, but without success. No more remarkable fossil had ever been found, and no incident in the history of fossilization was more singular than that which this specimen displayed. The fossil was a series of mummies of minute plesiosaurs less than five inches in length, which had the substance of their flesh perfectly preserved, and the bones in place within the flesh. The remains showed different conditions of development. This was the only case that had ever occurred of the mineralization of the muscular substance and the preservation of the external form of these animals; and so perfectly had they kept that the circle of the eye was preserved and the constituent bones could be distinguished.

Hints about Local Museums.—The British Association's Committee on Provincial Museums advises in its report that each such institution ought to be a fully illustrated monograph of its own district. If the entire history of the district and its inhabitants is represented in it, with special attention to any group of objects for which the district is remarkable, this will be almost as much as any local institution can accomplish. But science is daily becoming more exacting in its demands. Details which were thought ample in any provincial museum twenty years ago, would now be regarded as quite insufficient. In order that the scientific statistics of the country may be thoroughly investigated and made known as quickly as possible, a more business-like system of collection should be adopted. The district should be divided into sections, and a paid collector appointed for each of them, whose whole time should be occupied for several years in obtaining specimens and records in every branch of science represented in the museum. This would require a more liberal supply of funds for the first few years than museums usually enjoy, but the value of the museum would be immensely enhanced, and, when the local collections were made tolerably complete, the permanent income required for maintenance would be very much less. The town museum should be the place to which all students and teachers of science in the district would naturally go for assistance.

The Teaching of Chemistry.—The address of Prof. Tilden, as President of the Chemical Section of the British Association, was on the teaching of chemistry. In reviewing the present position of this instruction in England, the author thought the apparent inactivity of the chemical schools was not generally the fault of the professors, but was chargeable in the main to the ignorance, and partly to the indifference, of the public. There exists as yet no intelligent feeling in favor of learning, nor indeed in favor of any sort of education, unless there is expectation of direct returns in the form of obvious practical results. That teachers ought to engage in research at all is by no means clear to the public and to those who are charged with the administration of the new institutions. A popular mistake consists in regarding a professor as a living embodiment of science—complete, infallible, mysterious; whereas, in truth, he is or ought to be only a senior student, who devotes the greater part of his time to extending and consolidating his own knowledge for the benefit of those who come to learn of him, not only what lies within the boundaries of the known, but how to penetrate into the far greater region of the unknown. Moreover, the man who has no intellectual independence, and simply accepts other people's views without challenge, is pretty certain to make the stock of knowledge with which he sets out in life do service to the end. That one may be fitted to form a sound judgment concerning new theories, he must be familiar with the methods by which progress is accomplished. The work of investigation then reacts beneficially upon the work of teaching; that is to say, teachers should be encouraged, nay, even required to investigate, and not because their discoveries may haply prove to be practically useful. Every teacher who has attained eminence as a teacher, who has drawn men after him, who has founded a school of thought, and has left his mark upon his generation, has been an industrious worker in research of some kind.

A Law of Marriage Customs.—With the view of applying direct numerical method to anthropology, Mr. E. B. Tylor has compiled schedules of the systems of marriage among some three hundred and fifty peoples of the world, so as to ascertain by means of a "method of adhesions" how far each rule coexists or not with other rules, and what have been the directions of development from one rule to another. The barbaric custom which forbids the husband and his wife's parents, though on a friendly footing, to speak to or look at one another, or the converse custom of the wife and her husband's relatives being obliged ceremonially to cut one another, is practiced by some seventy peoples. A marked distinction is found to lie between those peoples whose custom is for the husband to reside with his wife's family, and those where he removes her to his own home. It appears that the avoidance custom between the husband and the wife's family belongs preponderantly to the group of cases where the husband goes to live with his wife's family. This implies a casual connection between the customs of avoidance and residence, suggesting as a reason that the husband, being an interloper in the wife's family, must be treated as a stranger, or not "recognized." Other varieties of the custom show similar preponderant adhesions.

The American Badger.—The mammalian fauna of the United States includes two species of badgers—the American badger (*Taxidea americana americana*) and the Mexican badger (*T. a. berlandieri*), the latter being found on our southwestern border. Dr. R. W. Shufeldt, U. S. A., says that many writers have confounded our species with the European badger (*Meles*), though in reality they are very distinct animals. The American badger is found in this country from Texas, Iowa, and Wisconsin westward, and used to occur much further east. Dr. Shufeldt had a fine one in captivity for a long time at Fort Wingate, and has seen a number of others there, among them being the largest that he ever saw or read about. It was an adult male, and measured from the tip of his nose to the tip of his tail thirty-two inches. Badgers take a varied diet of fruit, birds' eggs, insects, frogs, small mammals, nuts, and roots. It has not been proved that the American badger is as fond of honey as the European species is, and generally its tastes are far more carnivorous. They drink a great deal of water. They spend most of the daytime in the extensive burrows which their enormous fore-claws enable them to excavate, coming out to feed chiefly at night. It is very rare to find a pair of them together. When one has been chased into its burrow it sometimes reappears in a moment or two at the entrance to inspect its pursuer. Dr. Shufeldt has seen Indians take advantage of this habit by running up to the hole and killing the animal with a pistol-shot as it showed its head. Few animals prey upon or molest the badger; it is a strong and determined fighter, and even the wolf and the coyote do not care to attack it. Prof. Elliott Coues, in his "Fur-bearing Animals," says that "the flesh of the badger, like that of the skunk, is eatable, and doubtless often eaten by savage tribes, though not to be recommended to a cultivated palate." Dr. Shufeldt found that the specimens which he skinned emitted during the process a most rank odor. The badger yields a valuable fur. Thousands of shaving-brushes are said to be made annually from the long hairs, from which also the "badger blender" used by artists is made. The colors of the badger pelt are blended gray, tawny, black, and white, the colors ringed in alternation on individual hairs. The gray predominates. Much remains to be observed in regard to the more obscure habits of the badger.

A Phonetic Alphabet for Indian Languages.—Mr. Garrick Mallery, in preparing the phonetic alphabet used by the Bureau of Ethnology in recording Indian languages, while seeking for a distinct character for every sound, made it a fundamental rule that the characters should be limited to those in an ordinary font of English type—including with the Roman alphabet other characters and diacritical marks common in newspaper printers' cases. The range of characters is extended by reversing those letters of the Roman alphabet which look markedly different when reversed. This is entirely convenient to the printer, and does not occasion awkwardness in the current script to the recorder or writer for the press, as he has only to mark the letter intended to be reversed, after writing it in the normal manner, and to notify the printer accordingly. In practice, the letters intended to be reversed are marked by a cross beneath them. The result of this scheme in practice has solved one part of the problem of a universal phonetic alphabet. Vocabularies and chrestomathies of unwritten languages have been recorded and printed, on which grammars and dictionaries have also been prepared and printed, and from them the languages can be learned so as to be spoken intelligibly without oral instruction.

The Storage of Life.—In an address delivered at the Royal Institution, London, Dr. B. W. Richardson discussed the conditions of the storing or laying up of life, of which the cases of great longevity frequently met with are examples. He puts "hereditary qualification" first of these conditions, and says that the person gifted with this faculty of storage may be of fragile and delicate build, may even be deformed, may be of dull or of bright intellect, may be of cleanly or of uncleanly habit, may be placed in what would seem the most unfavorable position in life, and will continue to live on so as to see all of his more fortunate neighbors fall. The two hereditary temperaments which are incompatible with storage of life are the nervous and the lymphatic; the two which are compatible, and perhaps necessary, are the sanguine and the bilious; better, perhaps, than any singly, would be a mixture of the two latter. In the organism best constituted for storage, the color of the eyes, always an excellent test, is a light hazel, the hair is dark brown, the color of the skin is inclined to be florid, and the lips and eyelids are of good natural red. Dr. Richardson is confident that the number of persons who reach the classical threescore years and ten in England at present is much above what it has ever been in the history of the country. Toward improving heredity in the direction of longevity, the first consideration is the selection of lives for parentage. If such a social miracle could be performed as the fashion of a proper arrangement to prevent the marriage of health with disease, or, still more urgently, the intermarriage of disease, there would soon be an important advance in the value of life. A strong aid to the force of heredity is the virtue of continency, or that virtue which would provide for the limitation of the family circle to such a degree that the resources of the family may never be dangerously taxed by the largeness of it. Another aid is rendered by the art of training the body in such form that all parts of it shall be kept in perfect balance and in equal health. "I do not remember," says Dr. Richardson, "any one of fine and vigorous frame of body and mind who, dying prematurely, did not die from the failure of some one vital organ almost exclusively." A weak and well-balanced body is practically a stronger body than a strong and unbalanced one, and a body of original strength and beauty may be made of unusually long or of unusually short life, according as it is trained into the conditions leading to the one or the other. The storage of life is promoted also by that stoical virtue which may be summed up in the term perfected or all-round temperance. I include in this term not merely abstinence from stimulating or alcoholic drinks. The storage of life is reduced by intemperance of speech, of action, and even of thought. We may consider that whatever quickens the action of the heart beyond its natural bounds is a form of intemperance. The wild hope or wilder despair of the money-market, unbridled passion, and jealousy, are among the kinds of stimulation that hasten the decline of heart-power. The existence among men of diseases which lead to physical deterioration, and reduce the capacity for the storage of life, not alone in one but through many generations, is the last subject to which there is time to refer. The alcoholic diseases, the scrofulous and phthisical, the malignant or cancerous, the syphilitic, are diseases of this order, and whoever helps to remove them by getting at and removing their causes is among the truest friends that humanity ever possessed.

Protection of Wood aaginst Fire.—An investigation has been made by Profs. Boudin and Donny, of the Ghent University, at the requisition of the Belgian Minister of Public Works, in regard to rendering wood uninflammable. They reported that to deprive wood to a considerable extent of the property of catching and communicating fire it is sufficient to coat it with a suitable composition. A practical process must not be too expensive, nor take too much time, and the substance used must not attack any metal used in connection with the wood. Two methods of treatment may be mentioned. One is the injection of saline solutions, which appears but little applicable except to small pieces of wood, and may be dangerous in the case of wood of large dimensions. A concentrated solution of phosphate of ammonia, although expensive, is undoubtedly the best substance to apply by injection. Certain substances, notably chloride of calcium, should be rigorously excluded, because they would keep the wood constantly damp. This method may be applied to small articles by immersion, and the solution should be hot. In the majority of cases, including existing structures, applying some coating with a brush is the only practicable treatment. The wood thus coated should present a neat appearance, should be capable of receiving a coat of ordinary paint, nor should either coating deteriorate within a moderate time. The best substances for such application are cyanide of potassium and asbestus paint.

Tests of Eye-Sight, Hand-Grip, and Breathing Capacity.—Some curious observations on men and women were reported from the Anthropometric Laboratory at Manchester to the British Association. Of members of the association who were tested at the museum for keenness of eye-sight, the men could see diamond type with their right eye at a distance of 19·6 inches, and with their left eye at a distance of 18·2 inches, showing a distinct difference between right and left. A similar difference was manifested among the women, who with their right eye saw at a distance of 19·2 inches, and with the left at a distance of 18·7 inches. The men averaged 41·7 years of age, and the women were between 23 and 25 years. In no case could one see (diamond type) more than 34 inches with the right eye, but with the left one could see beyond that distance. Among 102 men and 98 women, the right eye was equal to the left in 26 instances in the men and 31 in the women; in 35 instances among the men and 28 among the women the right eye could see further than the left, and in 24 cases in the men and 28 in the women the right eye was worse than the left. The strength of the squeeze showed that it was not uncommon to find a difference of 5 or 6, or even 10 pounds between the squeezing power of the two hands. The average squeeze of the men was between 35 and 45 kilos, and that of the women about 25 kilos. The average weight of the men was between 11 and 12 stone, and that of the women about two stone less; the height of the men 68 inches, and of the women 4 inches less. Speaking of the effects of stays, which Dr. Garson said interfere with the abdominal respiration, Mrs. Stokes observed that the statistics of the stay and corset makers and sellers of London showed that the average size of the female waist had decreased during the last twenty-five years by two inches. Concerning the breathing capacity of some who wore no stays, Dr. Wilberforce Smith said that one woman 59 inches in height, whose breathing capacity, according to the usual average, should be 100, had an actual capacity of 135; another, whose average should be 115, had actual 158; a third, average 130, actual 150; a fourth, average 130, actual 200; a fifth, average 162, actual 195. In one person, in feeble health, the actual was less than the average.

The Chinese and their Limbs.—The Chinese, according to the "North China Herald," are opposed to having amputations performed upon them, not because they are afraid of the pain, but because they look upon it as a duty to keep the body intact. If they submit to it, they ask for the severed member, and keep it in a box, to be buried, in due time, with the owner. Sometimes they will eat it, in the thought that it is right that that which has been taken from the body should be returned to it. So an extracted tooth will be preserved, or ground to powder and swallowed in water. They also have a notion that a sick parent can be cured by broth made from flesh cut from a living child, and it is looked upon as a sign of filial piety for a child to submit himself to an operation for that purpose. The child is supposed to be of the vital essence of the parent, and it is thought that, if a part of this essence is returned to the fountain-head, the parent will be greatly strengthened.

Water-Storage at River-Heads.—Mr. J. Bailey Denton proposed, in the British Association, a plan for replenishing the subterranean supplies of the underground strata by means of shafts to be sunk down to the line of their saturation. He computes that of the twenty-seven inches forming the mean annual rainfall, about two thirds, or eighteen inches, are evaporated from the surface, while of the remaining third, four inches serve to maintain the river systems, and five inches pass away as floods and freshets. As the amount of evaporation is nearly a constant figure, and the quantity required to maintain effectually the river system necessarily remains the same under all conditions, the amount of flood or excess of water greatly varies. To make good the loss of this surplus water, the author proposes that whenever the water in the river rises above a certain datum height recognized as the gauge of its full service, the excess shall be diverted out of the river-course on to filter-beds formed near at hand. The outlet from these filter-beds would be steined shafts or sumps sunk down to the water-level beneath, and into them the filtered water would pass after it was freed from flocculent matter. The steined shafts would be made water-tight and sealed against all surface contamination.

Monopolies.—In a British Association paper on "The Growth of Monopoly, and its Bearing on the Functions of the State," Prof. H. S. Fox well pointed out that, whereas the general expectations of Adam Smith and his contemporaries were that the reforms they advocated would introduce an era of free competition and abolish monopoly, a century's experience had shown us that they had merely shifted the basis on which monopoly rested, and given it a secure seat. Liberty had not led to equal ty. Competition was a transitional, not a permanent stage. It merely substituted for monopoly based on privilege monopoly based on natural selection. All the most characteristic tendencies of the age favor the growth of monopoly. Monopolies thus arising were free from many of the defects of the old monopolies, and presented advantages over a state of unmitigated competition. But they had their special dangers, and required appropriate forms of state control. There need be an extension of the objects and principles of state control as generally indicated by Adam Smith and Mill. Whatever might be the case under a competitive system, monopolies could not be wholly self-regulating. The modern question was no longer between *laissez faire* and legislation, but between regulation and collecticism.

The Telephone Two Hundred Years ago.—How rare it is to discover anything that is entirely new is freshly exemplified to us in what Robert Hooke wrote about what has become the telephone, as far back as 1664, or two hundred and twenty-four years ago. He said: "And as glasses have highly promoted our seeing, so it is not improbable but that there may be found many mechanical inventions to improve our other senses, of hearing, smelling, tasting, touching. 'Tis not impossible to hear a whisper a furlong's distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiplied. And though some famous authors have affirmed it impossible to hear through the thinnest plate of Muscovy glass, yet I know a way by which it is easy enough to hear one speak through a wall a yard thick. It has not yet been examined how far octocoustics may be improved, nor what other ways there may be of quickening our hearing, or conveying sound through other bodies than the air; for that is not the only medium. I can assure the reader that I have, by the help of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light; at least, incomparably swifter than that which at the same time was propagated through the air; and this not only in a straight line, or direct, but in one bended in many angles."

The Destructive White Ant.—There is something terrible in the destruction which the white ant, or termite, is capable of inflicting on whatever articles of wood it attacks. There is, at the South Kensington Museum, what is left of a heavy, square door-lintel of teak-wood, after the ants had operated on it at St. Helena. It was reduced to a mere skeleton of the heart-wood, looking like a gnarled and knotty smaller limb. Mr. John R. Coryell relates, in the "Scientific American," that he once, in southern China, attempted to have a large hard-wood chest filled with books removed. When the men tried to lift it by the iron handles, it all crumbled and fell to the floor, a heap of dust and splinters; and the books were in the same condition. The ants are even dangerous to metals, and a piece of lead is exhibited at South Kensington which has been eaten into holes by them. Only camphor will keep them away. The destructive powers last during the whole life of the ant, and are exercised, in nearly equal degree, in the stages of larva, pupa, and perfect insect. The termites are extremely productive, and, were it not that they are very easily destroyed, might soon possess the world. One female will lay in the neighborhood of thirty-one million eggs in the course of the year. The males and females are endowed with wings at the pairing-season, when they sometimes fill the air in their flight. The majority of them lose their lives at that time, else they would multiply so as to make other existence intolerable. The females which are not destroyed are taken in hand by "workers," and imprisoned in a large cell, where they lay their eggs, at the rate of eighty thousand a day, which are at once taken by the "workers" to their particular cells. The female holds within her body, when pregnant, all the eggs she is ever going to lay, and there are thirty-one millions of them. The effect of breeding so enormous a mass is to swell her body so that, when she begins to lay, she will weigh a thousand times as much as when she took her pairing-flight. The wood-eating termite makes its home underground, and approaches the object it is going to consume by tunneling to it. Usually it follows the grain of the wood, or whatever course may be most convenient; and sometimes it fills the hollow shell from which it has eaten the substance with a packing of mud; and thus it happens that posts, etc., which the ant has eaten, do not give way. In all its operations it shows high intelligence and a genius for contrivance.

African Roads.—According to Colonel Sir C. W. Wilson, the roads over which the land trade of equatorial Africa now passes from the coast to the interior are mere footpaths, described by Prof. Drummond in his book on "Tropical Africa" as being never over a foot in breadth, beaten as hard as adamant, and rutted beneath the level of the forest-bed by centuries of native traffic. "As a rule, these footpaths are marvelously direct, running straight through everything, ridge and mountain and valley, never shying at obstacles, never turning aside to breathe. Yet within this general straightforwardness there is a singular eccentricity and indirectness in detail. Although the African footpath is, on the whole, a bee-line, not fifty yards of it are ever straight. And the reason is not far to seek. If a stone is encountered, no native will ever think of removing it. Why should he? It is easier to walk around it. The next man who comes that way will do the same. . . . Whatever the cause, it is certain that, for persistent straightforwardness in the general, and utter vacillation and irresolution in the particular, the African roads are unique in engineering. No country in the world is better supplied with paths; every village is connected with some other village, every tribe with the next tribe; and it is possible for the traveler to cross Africa without being once off a beaten track."

Educational Value of Phonetic Spelling.—Mr. Isaac Pitman, in a paper on economy in education and in writing, stated to the British Association that a million pounds yearly are wasted by the present method of teaching reading in the English elementary schools. The first occupation of children in schools is to learn to read, and they spend, at the lowest reckoning, eight hours a week, during the first four years of their school-life, in gaining a certain amount of reading power. An equal degree of proficiency might be gained by using phonetically printed books during the first two years, and by reading in the present books afterward. The cost of teaching reading to the children in the elementary schools is about two million pounds. One half of this sum would be saved by the use of an alphabet containing a letter for each sound in the language. As reading is now taught, the sound or pronunciation of every word has to be learned independently of the names of the letters that compose it, and generally in spite of the names or sounds of the letters; but, by the use of letters that make up the sound of a word, certainty and celerity in the art of reading take the place of doubt and difficulty. In the discussion on this paper, Dr. J. H. Gladstone said that children should be taught the properties and attributes of things in nature surrounding them, before they were taught mere intricacies of language, so that the child should be thoroughly educated in mind, body, and soul. He rejoiced to find that there was a great advance in the direction of spelling reform, because it was now being found out that our present system was productive of enormous expense, difficulties, and wasted energy.

An Eyeless Child.—A girl thirteen years of age has been exhibited by Dr. Menacho, at the Cataluña Academy of Medical Sciences, in whom, while the eyelids, lachrymal apparatus, and orbits appeared to be well formed, there was no eye on either side, but in its place a simple cavity could be seen on separating the eyelids. This cavity was invested by the conjunctiva, which apparently rested on some firm fibrous basis, in which movements could be detected, as if there were rudiments of the ocular muscles. In the thickness of both inferior eyelids a kind of bursa or cyst could be felt, that on the left side being the larger and having a whitish coat like the sclerotic, which could be seen through the conjunctiva posteriorly, where it was thin and transparent. This became tense during crying, and the child was observed to press it frequently with her hands, and then to smile. It is supposed that a subjective sensation of light was thus produced.

NOTES.

The first part of Prof. Topinard's paper on "The Last Stages in the Genealogy of Man," the conclusion of which is given in this number of the "Monthly," was published in the October number. The remainder of the paper was omitted from the November number, in which it should regularly have appeared, on account of the pressure of matter claiming insertion.

Prof. W. H. Flower has been chosen President of the British Association for next year. The meeting will be held at Newcastle-on-Tyne, and the meeting for 1890 will be held at Leeds.

Locusts, which are a great nuisance there, are trapped in Cyprus by means of a screen of canvas having at the top a strip of smooth oil-cloth up which the insects can not crawl. They are thus compelled to creep along the screen and fall into holes, from which their exit is prevented by a somewhat similar contrivance. They are then buried. The system has been very successful, and gives hope that the locusts may ultimately be exterminated. Birds are also effective in destroying the pests. Canon Tristram tells of an instance in which a mass of locust-grubs so thick as to cover the ground was entirely devoured in a very short time by a certain species which followed them in large flocks.

Mr. E. B. Poulton reports to the British Association every two years his observations upon a family of many-toed cats, of which he has individuals down to the tenth generation. They originated from a cat named Punch, which had six toes on each foot. The peculiarity appeared with more or less modification in a large number of his descendants, some of which had seven toes on each foot.

According to Sir John Lubbock, about 4,500 species of wild bees are known, and 1,100 of wasps, of which 170 and 16 respectively live in Britain. Their habits differ in almost every genus, and some offer points of great interest. The amophilla, having built her nest, places in it as food for the young a full-grown moth. This must be prevented from escaping, yet must not be killed; the wasp paralyzes it by a series of carefully adjusted stings, and crushes its head, leaving it alive, but without the power of motion. There appears to be some evidence that the mother-wasp can control the sex of the egg. Sir John mentions the death of a queen-ant which had lived in one of his nests since 1874, and must therefore have been fourteen years old, much the oldest insect on record.

A new view of the value of the study of anthropology, as popularized in such a museum as he would design, is given by Lieutenant-General Pitt-Rivers, in his address at the British Association. He says: "It would adapt itself more especially to the limited time for study at the disposal of the working-classes, for whose education . . . we are all most deeply concerned. Anything which tends to impress the mind with the slow growth and stability of human institutions and industries, and their dependence upon antiquity, must contribute to check revolutionary ideas."

Copenhagen was visited by a blizzard at about the same time that our Atlantic coast was suffering from the affliction. It began on the 10th of March and continued to the 13th, piling up the snow to fabulous heights, and accompanied with intense cold. The city was wholly cut off from surrounding districts. The straits between Sweden and the Danish islands were at the same time covered with a tolerably thick ice. It is a curious coincidence that in 1788 the snow fell so deep in Scandinavia that it had not wholly disappeared in the following June.

A RACE between bees and pigeons took place at Hamme, Westphalia, in July, 1888. Twelve bees, having been rolled in flour to mark them, and twelve pigeons belonging to a fancier in the village, were let loose at Rhynern, about a league away. The first bee reached home a quarter of a minute before the first pigeon, and the rest of both squads arrived at the same instant a few moments afterward.

ONE of the most obvious benefits of the present popularity of out-door games, like lawn-tennis, among women, is that it will compel attention to the provision of more free-fitting and hygienic dress. These games can not be played with tight-fitting and peg-heeled shoes. Hence, looser shoes with reasonable heels are worn for this game, and are coming into more general use for ordinary wear. Loose-fitting robes are also necessary in lawn-tennis, and their advantages for other occupations are likewise becoming apparent.

ACCORDING to Prof. Oliver J. Lodge, the two main destructive aspects of a lightning-flash are its disruptive or expanding or exploding violence, and its heat. The heating effect is more to be dreaded when the flash is slow and much resisted; the bursting effect when conducted well, except at a few places. A noteworthy though obvious thing is, that the energy of the discharge must be got rid of somehow. The question is, how best to distribute it. The disruptive result is well shown by the effect of lightning on trees. It is as if every cell were burst by the expansion in the path of the discharge. The effect on conductors is, however, just as marked.

ARSENIC is still too freely used in goods designed for the decoration of rooms. What might have proved a serious epidemic if the goods had not been removed was started recently in a civil-engineering college in England from the brilliantly colored cretonne and muslin hangings of some of the students' rooms. Even such colors as black and dark blue, in which the presence of arsenic is not likely to be suspected, have sometimes been found unsafe.

THE order of the Rising Sun has been conferred by the Mikado on Prof. John Milne, of the Imperial University of Tokio, Japan.

A CASE is reported by H. Mallins, in which a skin-disease was transmitted from a cow to a family of children who used the milk. In the cow the disease took the form of a rash, mostly dry, all over the body. In the children it showed itself first in small, blister-like vesicles on the tongue and mucous membrane of the mouth, followed in three weeks by a limited number of vesicular eruptions on various parts of the body, which formed sores and left dark-red scars.

A SURVEY of the Nicobar Islands has been made by Colonel Strahan, of the India Survey. The total area of the group is 618 square miles, and its culminating point is 2,105 feet above the sea. The scenery is of "indescribable beauty." Several rivers are navigable by boats for some miles, of which the Galatea, fringed with a luxuriant tropical vegetation and presenting occasional glimpses of distant mountains, runs through a region only sparsely inhabited, by a tribe so utterly barbarous as to be despised by their fellow-barbarian Nicobarese of the coasts. The inhabitants as a rule are allied to the Malays, of good physical development and a reddish-brown color, are unconquerably lazy, and show great talent for learning languages.

IT has been observed that pure sesquioxide of iron, added in small quantities to carbonate of lime, communicates to it the property of fluorescence after calcination in the air.

THE British Registarar-General has published statistics bearing upon the increase in the death-rate from cancer during thirty-five years, and upon the geographical distribution of the disease. The increase in England and Wales in the ten years 1871–'80, as compared with the decade 1851–'60, was equal to sixty-two per cent among male and forty-three per cent among female patients. Cancer appears to prevail most extensively in London and its environs—possibly by reason of the attractions offered to patients by its hospitals—and in Devonshire—possibly on account of the health-resorts.

THE English "Sporting and Dramatic News," while it admits the desirability of revising the rules of foot-ball so as to make it less rough and dangerous, pleads for the retention of the sport, because it is essentially a poor man's game. It needs no costly outfit, and does not call for very serious traveling expenses. But for the very reason that the bulk of foot-ballers are, comparatively speaking, poor men, they should be as exempt as possible from injury, for they can not afford to be laid up.

THE process of unliming hides and skins in tanning has been a slow and disgusting one, consisting in soaking the skins in a bath of manure in water, called *bate*. A new method comes from Australia, and consists simply in utilizing the power of dissolving lime possessed by water charged with carbonic-acid gas. The process has been patented and applied in England. A half-hour's soaking in the carbonic-acid bath is said to cleanse the skins so thoroughly that after scraping they absorb the tan with extreme readiness, and yield a very flexible and fine-grained leather. The inventor computes that at least one third of the time of leather-making is saved by his process.

A LITTLE drowsiness is natural to the work of digestion, and may be taken as a fair indication of its activity; but normally it should be no more than can be overcome by an easy diversion. When the tendency to sleep regularly follows a meal and is well marked, it must be explained in some other way—perhaps by excess of food, or some special bodily condition. The effect of actual sleep on digestion can not be immediately helpful, for, during its continuance, all the bodily operations are slower, but a good effect may possibly follow in the greater energy of life after a little rest. Persons who sleep after eating should take account of the fact in fixing the hour for the next meal.

AN English brewer, recently deceased, Mr. Richard Berridge, has left a fund of £200,000, or $1,000,000, to be applied to the advancement of economic and sanitary science.

IT is remarked, in connection with the active sanitary measures that have been set on foot in Japan since the cholera epidemic of 1886, that the people themselves have come largely to appreciate the importance of sanitation, and the work is going on "smoothly between the authorities and the people, without the least misunderstanding or ill feeling."

A PIECE of dry biscuit has been found by W. J. Russell to possess an odor which could be perceived by a pug dog at a distance of several inches, when hidden and covered up, and even when its smell was disguised by cologne-water. In every instance the dog, when called in, was able to find the biscuit in less than a minute.

A STORY is told in the north of England papers of a person, who, having had his right eye destroyed and his frontal bone broken by an explosion, and lost also the vision of his left eye, from shock to the retina, it is supposed, had his vision restored by lightning. During a severe thunder-storm he remarked that he saw light through his spectacles, and immediately afterward experienced a piercing sensation passing from his eye to the back of his head, after which he found that he could see indistinctly the objects near him. The next day he was able to walk about the town without a guide.

THE nations which still eat with the fingers defend the practice on the ground of cleanliness. A Malay gentleman regards the use of a fork much as we should think of the use of a borrowed tooth-pick. He is troubled by the reflection that it has been in other mouths, and that some lazy servant may have neglected to wash it properly. The care of his fingers is in his own charge, and he knows that they are clean, and that they have never been in any one else's mouth.

THE statistics of blindness in Russia go to show that the affliction prevails more widely among the Ural-Altayans, and especially among the Finnish-Mongolian stems, than among the Aryans and Shemites, although the conditions of these races, so far as poverty is concerned, are much the same. One eighth of all the cases are due to small-pox, and one half only to direct eye-diseases.

IT is said that the ivory produced by eight hundred elephants is consumed every year by a single firm only—Messrs. Rodgers and Sons, cutlers, of Sheffield.

DR. DEFONTAINE, of the Creuzot steel-works, has described an affection which he calls electric sunstroke, to which the workmen in that factory are subject. The electric furnace, which is essentially an arc-light of 100,000 candle-power, produces upon the workmen all the symptoms of sunstroke. Although protected by dark glasses, the retina of the eye is painfully affected, the sight is very considerably disturbed, a copious discharge of tears is kept up, headache and sleeplessness are engendered, and the skin of the face peels off.

IT is quite generally known that the correction which each astronomer has to make to his observations, called his "personal equation," represents the slight delay which occurs after his eye observes an event and before his hand records it. The time required for the passage of a nervous impulse from the retina to the brain, its translation there into terms of consciousness, the sending of an efferent nervous impulse to the hand, and the setting in motion the muscles which move the recording-instrument, differs in different persons—hence the personal nature of the correction. It is not so well known, however, that the personal equation of an observer is determined, not with reference to the actual time of the event, but with reference to the time as observed by some particular observer, who is taken as a standard, his equation being arbitrarily assumed to be zero. Hence it sometimes occurs that a personal equation is a minus quantity, but this does not signify that the observer anticipates events, it shows only that he loses less time than the standard man with whom he is compared.

THE doctrine that cold or chill is a general cause of such diseases as bronchitis, pneumonia, pleurisy, and rheumatism, is disputed by Dr. W. H. Ransom, of Nottingham. While admitting that such diseases are apt to appear during cold seasons and in cold or temperate latitudes, he has failed to observe such a direct correspondence between the chill and the disease as would satisfy him of the existence of a valid relationship of cause and effect; and he is disposed to regard the chill as a coefficient of the cause rather than the primary excitant itself.

MOSES ASHLEY CURTIS.

THE

POPULAR SCIENCE MONTHLY.

JANUARY, 1889.

THE GUIDING-NEEDLE ON AN IRON SHIP.

By Lieutenant-Commander T. A. LYONS, U. S. Navy.

THERE is an agency that pervades the earth and is peculiarly resident in all its iron. It is magnetism. This force is akin to electricity, though not identical with it, and the manifestations of both are often similar.

The small steel wire, scarcely larger than a sewing-needle, which constitutes the mariner's compass—every iron vessel, even the huge steamship City of New York, and the earth itself—all have certain properties in common that warrant classing them as magnets; and, as the ship sails the earth and is guided by the compass, there is a very intimate though varying relationship between these three that should deeply interest those who traverse the ocean. To describe this relationship, its contentions, and the constant struggle of each member for mastery, rather than their amicable companionship, is the object of this article; and it will render our ideas of the subject clear if we begin by stating the properties of the ordinary bar-magnet. The needle, the ship, and the earth are but magnets of different size.

The Steel Bar-Magnet.—Fig. 1 represents a steel bar which has been magnetized. Its centers of power are located close to each extremity, while near the middle is a neutral ground over which the influence of neither end predominates. If fine iron filings be sprinkled around the magnet, they will form into curved lines emanating from each center, and eventually trending toward a union.

These centers are called poles. The magnetism in one is opposite in kind and equal in degree to that in the other; there is a mutual attraction between these opposite magnetisms, and this tendency to rush across the neutral ground, and, by combining, yield up every distinctive feature of the magnet, is successfully opposed by the hardness of the steel bar.

The lines are called lines of magnetic force, and the area over which their influence is felt is known as the magnetic field. If a compass-needle, suspended by a silk thread and free to move in any plane, be brought into this field, it will assume a direction

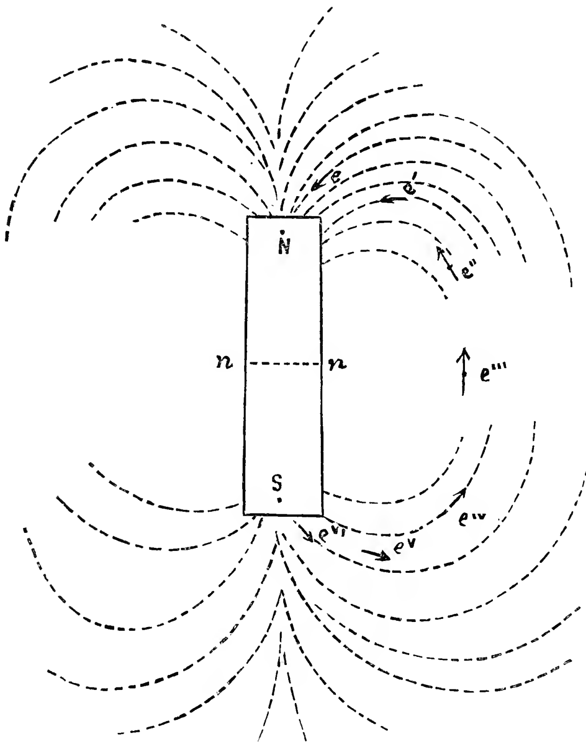


Fig. 1.—The Steel Bar-Magnet. *N* and *S*, poles; *n n*, neutral ground.

parallel to the lines of force, as at e, e', e'' . . . e^{vi}. The strength of the field, and hence the force that tends to give the needle steadiness and direction, varies greatly at different points—at e it is powerful, at e''' feeble.

If two magnets similar to that of Fig. 1 be brought into proximity, so that poles of the same name touch, they will repel each other; if, on the other hand, the north pole of one be approached to the south pole of the other, both bars, as if instinct with life, will fly into contact and cling one unto the other with the tenacity of a hundred arms. And this intense affinity of opposite magnetisms is a general characteristic.

THE EARTH A MAGNET.—Now, to show that the earth has magnetic features entirely analogous to those of the bar-magnet, we will examine Fig. 2. Here the parallels of latitude and meridians of longitude appear as regular curves. But from a focus at N radiate a series of curves which take sinuous forms and finally

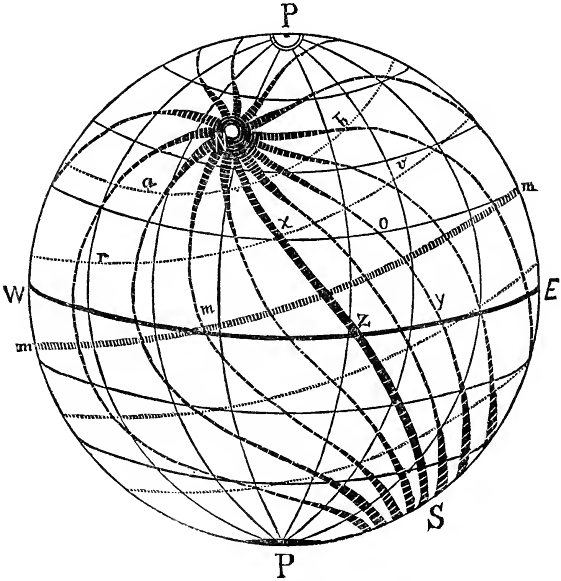


FIG. 2.—THE EARTH A MAGNET. *P P*, geographical poles; *N S*, magnetic poles; *m m*, magnetic equator; *r v* and *a b*, lines of equal magnetic dip; *x z* and *o y*, lines of equal magnetic variation.

converge toward another focus at the antipodes. These foci are the magnetic poles of the earth toward which the compass-needle ever points, not indeed directly, but parallel to the lines of force. These poles are not coincident with the geographical poles, but, on the contrary, are far removed from them.

There are other, but minor, magnetic foci on the earth, just as there are secondary poles in a bar-magnet, but so overtopped in prominence by the two grand foci that they scarcely deserve mention.

The lines issuing from one pole to meet again in the other are called lines of equal VARIATION; that is, a compass carried along one of them from north to south would always point at the same angle from the geographical meridian, and this angle may vary from 1° to nearly 90° in different parts of the globe.

Thus, then, the variation may be defined as the angle between the geographical meridian and the direction of the compass-needle.

Another set of interesting magnetic lines are those of equal DIP. They gird the earth in circles concentric with the magnetic poles, just as the parallels of latitude do the geographical poles. There is a magnetic equator along every point of which the compass-needle is horizontal. As we travel from the magnetic equator toward the north magnetic pole, the needle begins to incline, the north end tending downward until, when we reach the vicinity of the pole, the needle becomes vertical.

If we travel toward the south magnetic pole, the same occurs with the south end of the needle, now tending downward. An entirely similar experience will result from carrying a small needle through the magnetic field of the steel bar. At the neutral ground it will be parallel to the bar, while, as we approach either end, the dip toward the pole becomes more and more until it stands vertical at the pole. And as it was stated, regarding the steel bar, that the intensity of its magnetic field varies from point to point, so with the earth, it also has a magnetic field which is powerful near its poles and steadily moderates in strength as we approach the magnetic equator.

A third set of lines are those of equal INTENSITY. They are not drawn in Fig. 2. In general contour they follow those of equal dip, though, in point of fact, they are not identical with them.

All these different systems of magnetic lines—variation, dip, and intensity—have not on the earth that symmetry and regularity which they would present around a steel bar; on the contrary, they are often bent, looped, and turned into many a devious path—wherefore, none can tell. The fact alone is well established, while theories fail to account satisfactorily for the earth being an *irregular* magnet.

The observations that have determined the various magnetic features of the earth have been made with delicate instruments in stationary observatories in every country, and also on ships-of-war in every sea.

The magnetism of the earth is not fixed either in locality or amount; but the different systems of lines just described, and by which it has been found convenient to represent this magnetism, are ever varying—ever migratory. The hourly, daily, and other periodic changes are all small, it is true; but, however minute, they are the object of inquiry at every magnetic observatory, with the hope that in time, by the accumulation of data, a satisfactory theory of the earth's magnetism may be deduced.

As the part of the earth's magnetism which affects the compass-needle is the important factor of this article, since the needle, as an instrument of navigation, is specially treated, it will be necessary to dwell further on that element. It has already been stated that poles of opposite name attract and those of the same name repel each other. Now, on the earth, the pole nearest the geographical north is commonly known as the north magnetic pole, and the end of the needle pointing to it is also spoken of as the north pole, whence repulsion would, of necessity, seem to result; but this is an unfortunate use of terms that has grown up in daily life. The real state of the case is, that whichever of the two —the earth's pole, or that of the compass—we agree to designate as north, the other, having magnetism of the opposite kind, must be called south, and hence attraction naturally takes place. To show the variability of this attraction in direction and amount in various parts of the globe, we will examine Fig. 3.

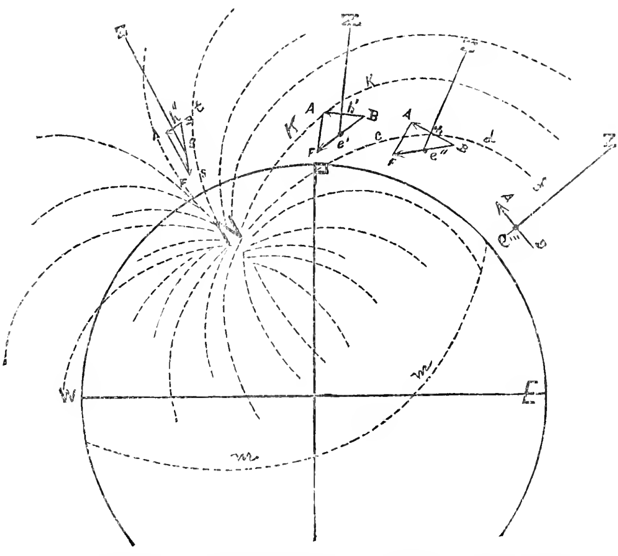


FIG. 3.—VARIABILITY OF THE EARTH'S MAGNETIC FORCE. *P*, geographical pole; *N*, magnetic pole; *m m*, magnetic equator; *Z*, zenith; *s t*, *K K*, *d f*, etc., earth's lines of magnetic force.

Let us conceive the air filled with iron particles as it is with congealed vapor on a wintry night: they will not float about, listless and without form, but, like the frosty foliage on a window-pane, will seem projected from a parent stem, shooting up and out in graceful, wavy filaments. They are the earth's magnetic lines of force permeating space (how far, I do not presume to say), and coming to a focus at the poles; the mariner's compass is everywhere subject to their influence, and it is this influence that gives steadiness and direction to the needle.

At e, e', e'', and e''' is a magnetic needle, represented as suspended at the middle by a thread from the zenith, and assuming, as it always will, a direction parallel to a line of force. At the magnetic equator ($m\ m$) this line is parallel to the horizon, and so is the needle e'''; we go north, and the line becomes bent, so the needle inclines as at e''; proceeding further, the line bends more and the needle inclines accordingly; finally, at e it is all but vertical in the vicinity of the pole. In all these cases the force or intensity of the magnetic field steadily increases from the first toward the last position of the needle, so that, if at e''' it be made to oscillate, the motion will be slow, extend over a wide sweep, and the needle will take some little time to come to rest; at e'' the vibration will be quicker, the arc smaller, and the time less; while at e we will have but a few quick, jerky movements, and then a stop, as if checked by a powerful strain.

Now, a needle dipping thus at every remove from equatorial regions is of no value to guide a ship; it must always be horizontal, and this is practically obtained by placing a small sliding counterpoise on the needle to overcome the downward pull of magnetism; it is easily adjusted with every change. In this constantly horizontal direction of the needle, however, the portion of the magnetic intensity that gives it steadiness is materially changed —lessened and more diminished as we proceed from e''' to e.

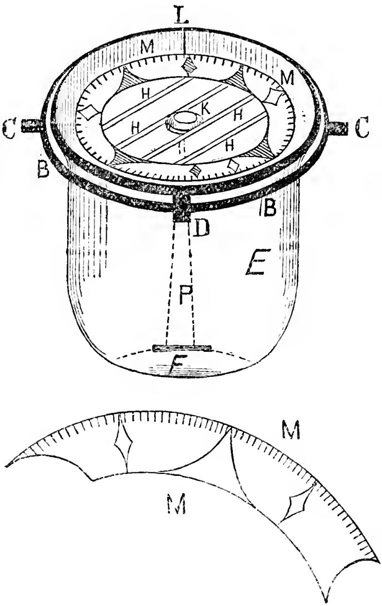
Let the length $A\ B$ at e''' and $F\ B$ at each of the other points e'', e', and e, represent the *total* force of the magnetic field at those places, then the *portion* of this intensity that is effective in horizontal planes will be represented by the length of the line $A\ B$, which is h, h', h'' at each point, and it is readily seen that these lengths are shorter and shorter. And the motion of the needle at h, h' and h'' successively will become slower, more sluggish and uncertain. Thus the seeming paradox is explained that, as we proceed from the magnetic equator toward its pole, the compass becomes less steady and reliable, while, at the same time, the *total* intensity of the magnetic field increases.

If a wooden ship with no metal other than copper in her frame were to sail round the globe, her compass, adjusted for dip, would experience only those magnetic phases that have already been described as peculiar to the earth—more or less steadying force and a variation of larger or smaller amount according to location; the ship herself would exert no influence whatever. But on board an iron or steel ship, with all her metal equipment and armament, the case is far otherwise; there, contention—unceasing strife—is ever active, as we shall see hereafter.

The Mariner's Compass.—To relate what is known or conjectured regarding the origin, history, and development of the compass would not be pertinent to this article, and, besides, such information is readily accessible in any encyclopædia; to impart in a general way a knowledge of its construction is more to the point, especially in view of the object of this paper, which is to treat of the behavior of the instrument in an iron ship; and this kind of knowledge is neither easily obtained nor generally free enough from technical terms to be readily intelligible to the non-professional reader.

Like almost every other instrument, the compass has representatives of many a type; to explain the mechanical and magnetical principles of construction, however, in their general application, it is necessary to have reference to some particular type, and for this purpose I shall select the one that in my opinion is the most trustworthy for steering a ship from her port of departure to her haven of destination—the Ritchie liquid compass. This is an American invention, Mr. E. S. Ritchie, of Boston, having many years ago taken out a patent for a liquid compass to be used at sea. From time to time it has been improved, until to-day, in the seven-and-a-half-inch compass supplied our navy, is probably realized the most accurate and complete instrument afloat. So generally has the excellent workmanship of the manufacturer been appreciated, that his compasses now guide the ships of many a nation in every sea. In the wheel-house of the latest large floating structure—the British steamship City of New York—will be found a Ritchie liquid compass.

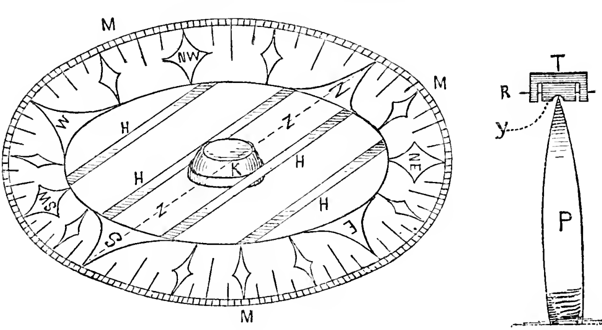
The compass and its several parts are represented in Figs. 4 to 7, and the reference-letters in every instance pertain to the same parts: *E* is a copper bowl, with two short arms, *D, D* (one only being visible), which rest in the grooves of an outer ring, *B*; this, in turn, has two short arms, *C, C*, which repose in the sockets of the *binnacle*, as the case for holding the compass on a ship is called. This method of suspension, termed *gimbals*, allows the bowl to swing freely in two planes, so that really it partakes but little of the rolling and pitching motion of the ship. A slender brass spindle known as the pivot (*P*, Figs. 4 and 7) is screwed into the bottom of the bowl, and on it rests the card. The bowl is filled with a liquid composed of nearly equal parts of pure alcohol and distilled water, and is hermetically sealed with a plane glass cover, which permits the card to be distinctly seen without distortion. The card (Fig. 6) consists of an outer rim (*M*), a central bulb (*K*), and four tubes, *H, H, H, H*—all made of very thin sheet-brass. The rim has double curvature—circular around the pivot, and semi-cylindrical from the inner to the outer edge, as shown in section in Fig. 5. The card is painted white, and has two systems of graduation traced upon its outer edge—degrees and points. The bulb is an air-tight ellipsoid, with a conical depression on its nether surface; in this depression is a small brass cap (*T*, Fig. 7), with four tiny set-screws (*R*, *R*)—only two are shown, however—which press and hold steady in place the jewel (*Y*)—a sapphire hollowed out and smoothed to the utmost degree, so that the highly polished pivot-point upon which it rests may encounter the least friction possible.



Figs. 4, 5.—United States Navy Compass.

The little set-screws are for adjusting the jewel to the very center of the graduated rim. The tubes, which are two of one length and two of another, are about the diameter of a lead-pencil; their extremities are soldered to the under edge of the rim, and in addition the two inner ones are soldered to the bulb *K*; this gives the rim rigidity, as of itself it is both light and flexible.

In the tubes are placed the magnets—the vital part of the compass. These magnets are prepared with the most scrupulous



Figs. 6, 7.—United States Navy Compass.

care. A quantity of the best steel wire, as thick as a knitting-needle, is selected and cut into lengths to fit the tubes; bundles of these wires large enough to enter the tubes are made up and tempered to the degree that experience has proved best for holding captive the magnetic charge. This is imparted to each bundle between the poles of a powerful electro-magnet. Of course, every one of the many slender wires that compose a bundle is itself a magnet; they lie together with their north poles in contact, and likewise their south poles: hence repulsion—a mutually deteriorating influence—is the result; and indeed ofttimes a bundle of wires loses much of its magnetic strength because the steel is not of a quality and temper to resist the destructive force.

Each bundle is weighed and its magnetic strength tested, and, in placing them on a card, due care is had to the equal distribution of weight and force on each side of the center, for the characteristic of symmetry is ever kept in view. The magnets, except one, are rigidly set in the tubes, and the latter sealed; the movable magnet has screws at one end for the purpose of adjusting the magnetic axis of the whole system to that diameter of the card which passes through the north and south points: it would be the imaginary dotted line (*Z* . . . *Z*) shown in Fig. 6.

The card as above described, with tubes, magnets, bulb, rim, brass cap, and jewel all in place, weighs many ounces—a heavy weight for the delicate force of terrestrial magnetism to turn about on a pivot, how highly soever both this and the jewel may be polished.

The essential principle observed in the manufacture of the instrument is to reduce the friction on the pivot to a minimum and increase the moving power—the strength of the magnets—to a maximum; and this object is greatly furthered by the introduction of the liquid: its buoyant effect upon the card reduces the pressure of several ounces to that of a few grains.

The liquid has another advantage—it steadies the card, prevents all those small oscillatory movements that characterize a dry or air compass, while at the same time enabling the magnetic power to cope more efficiently with its burden. The liquid must fill the bowl completely, otherwise an air-bubble would gather and impede the free motion of the card.

The same compass may guide a ship into all climates—polar seas and tropical oceans; but as every change of temperature causes a varying expansibility of the copper bowl and the liquid in it, the former, when filled to complete fullness, would soon burst, were no provision made for expansion. To prevent this, an air-tight case of thin flexible metal is placed in the bottom of the bowl, which contracts or expands with every changing pressure. The alcohol in the liquid is to guard against its freezing in cold weather.

It has been stated that a single needle suspended by a thread would dip more and more as one proceeded from the equator toward the pole; and that in the dry compass this is prevented and the card always maintained horizontal by an adjustable counterpoise on the needle: no such contrivance is needed in the liquid compass; any downward pull of the earth's magnetism is at once met by such opposite pressure of the liquid on the rim of the card as to neutralize it. Magnetic attraction and liquid pressure counterbalance, and the card remains horizontal.

On the inside of the bowl is traced a fine black line—the *lubber's-point*, or, as it has of recent years been more appropriately designated in the navy, the *keel-line* (*L*, Fig. 4). It is this line toward which the point of the card indicating the ship's course is always directed. The *binnacle* which holds the compass is screwed down to the deck, so that the keel-line, as its name indicates, is in the vertical plane through the keel of the ship, or in a plane parallel to that one. This plane extends from bow to stern, and divides the ship into two equal and symmetrical parts.

Now, let an observer look at the compass-card and keel-line while the ship's bow swings through a portion of a circle: as each point passes the keel-line, it will seem that the card itself is moving, but this is an illusion; the card is still—ever pointing to the magnetic pole, in obedience to the attraction that there exists for the magnetism in the steel wires it carries. But it must not be understood that this attraction is of a nature to pull the card off its pivot: on the contrary, there is no tendency to motion of translation, but merely of direction—to turn the magnets on their pivot and place them parallel to the earth's lines of magnetic force.

To illustrate this, let us examine Fig. 8: *C*, *C* is a steel arrow free to move upon a pivot *P*; from the extremities of the arrow light threads *t* . . . *t'*, extend and pass over revolving wheels at *N* and *S*; small, equal weights *Q* and *Q'* are attached to the ends of the threads. Under the strain communicated to the arrow by the weights, it will, of course, lie in the straight line joining the points *N* and *S*.

Now, with the fingers, turn the arrow into the position *C*, *C*, the threads will assume the positions *t*, *t'*, and both weights will be equally raised. Release the arrow suddenly, both weights will descend, and alternately rise and fall as the arrow makes a series of short and constantly diminishing vibrations, as shown in the positions *C'*, *C'* and *C"*, *C"*, until it finally comes to rest and all is still. Let us replace the arrow by a magnet, and the threads, wheels, and weights by that mysterious agency we call magnetism, and the oscillations of the magnet, when drawn out of parallelism to the lines of force, will be entirely similar. Such are the efforts of the compass to regain its normal direction when disturbed; and the test of a good compass is the sensitive quickness with which it will turn aside from the magnetic meridian when another magnet is brought near, and the celerity of its return thereto when the intruder is removed.

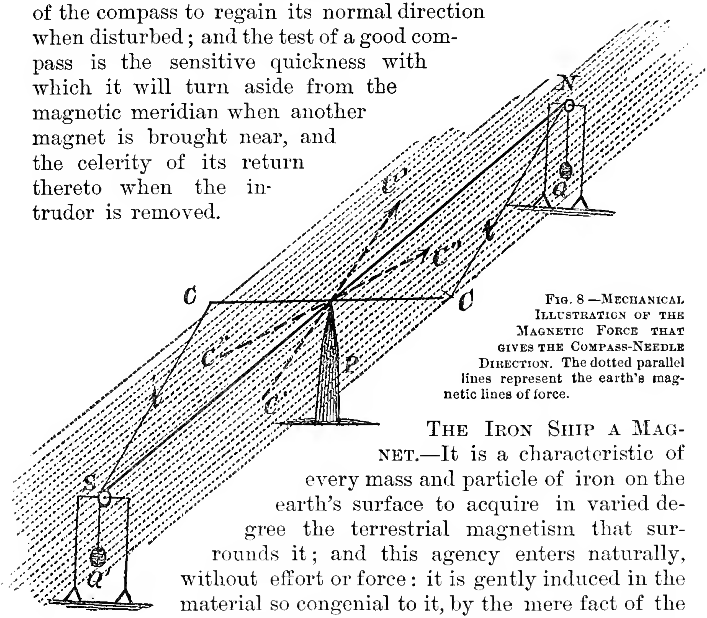


Fig. 8.—Mechanical Illustration of the Magnetic Force that gives the Compass-Needle Direction. The dotted parallel lines represent the earth's magnetic lines of force.

The Iron Ship a Magnet.—It is a characteristic of every mass and particle of iron on the earth's surface to acquire in varied degree the terrestrial magnetism that surrounds it; and this agency enters naturally, without effort or force: it is gently induced in the material so congenial to it, by the mere fact of the material quietly lying in its midst—the magnetic field, which pervades all space. And the word *iron* is not here used in a specific sense, but as a general term to include wrought-iron, cast-iron, and steel, which are all susceptible to magnetism.

The steel rails that afford transit from seaboard to interior, the trestle-work upon which the elevated trains traverse the metropolis, the heavy castings in a foundry, the massive forgings in a machine-shop, even the little scraps upon a neglected heap, have one and all magnetic features that distinguish them from other metals, and point out the common kindred among themselves. And these features are entirely analogous to those of the steel magnet already described—two poles, one at each end of the mass, with a neutral belt between.

Let us conceive a metallically pure cylinder of wrought or cast iron that has not been hammered, and let us further conceive it entirely free from magnetism: hold it vertically, and instantly the upper end becomes a south, and the lower a north pole (in this latitude). Reverse it as quickly as we may, and the magnetism also reverses, so that the upper and lower ends are still as they were before—a south and a north pole respectively.

Hold it horizontally in the meridian, and the end toward the north becomes a north pole, while that toward the south becomes a south pole. Revolve it slowly or rapidly in azimuth, and the foci of magnetic polarity also move with the fidelity of a shadow, until, when the cylinder points east and west, all the side facing the north is pervaded by north magnetism, and all facing the south by south magnetism. Again: let us conceive the hull of a ship to be like our cylinder of metallically pure wrought-iron, and as susceptible of magnetic induction in its ever-changing courses as the cylinder is when turned round. Then, as the ship steers north (in this latitude), the bow will become the center of north polarity, and the stern that of south polarity. As she gradually changes course to the eastward, so will the north focus shift to the port bow, the south focus to the starboard quarter, and the neutral line dividing them, which while the ship headed north was athwartship, will now become a diagonal from starboard bow to port quarter. When the ship heads east, all the starboard side is pervaded with south polarity, the port with north, and the neutral line takes a general fore-and-aft direction. Continuing to change course to the southward, the poles and neutral line continue their motion in the opposite direction, until at south the conditions at north are repeated, but this time it is the stern that is a north pole, while the bow is a south pole. At west the conditions at east prevail, only that it is now the starboard side that has north polarity, and the port side south polarity. And this transitory induction in both the cylinder and the ideal ship is solely due to the mild effect of the earth's magnetic field in which they move.

Now, to consider it in connection with an *actual* ship. The hull of no vessel is metallically pure, nor has it acquired shape and stability without much hammering; moreover, it can not be made an abstraction from a magnetic state. By hammering in the process of construction, it has been made as permanent and well defined a magnet as the steel bar, with poles and neutral line as in the bar, but located according to the magnetic direction in which the ship lay on the stocks, in strict conformity to the places they occupied in the ideal vessel just described. Therefore, it is not as susceptible of the mild magnetic induction of the earth as the cylinder and ideal hull, although the straining while on a passage and the buffeting of the waves do assist the inducing tendency; besides, once that the induced magnetism becomes lodged, it does not move and shift with the freedom and facility that it did in the cylinder; and finally, as it already finds a tenacious occupant of the vessel in its permanent magnetism, hammered into it while building, it must adapt itself to the greater power, and thus it is the resultant of both we always find, and not the individuality of either.

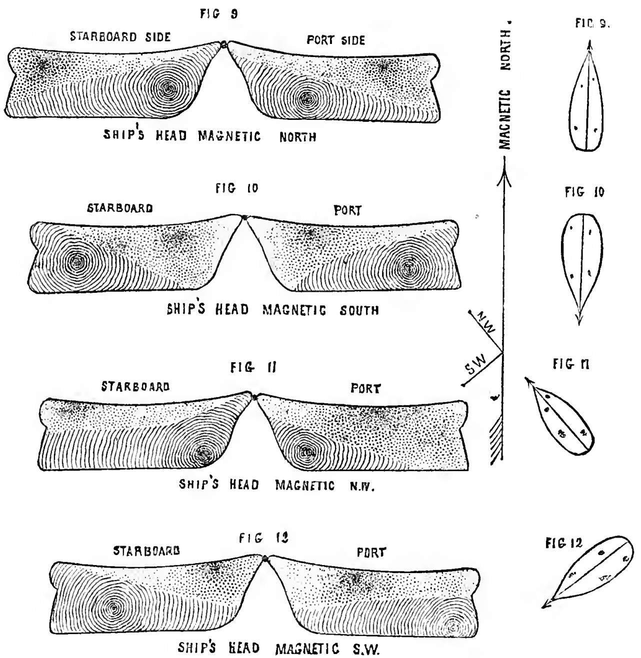
Time is a chief element in the acquisition and efficacy of this induced magnetism; for the longer a ship steers on a given course, or lies in the same general direction, the greater will be the magnetic charge, and the more slowly will it move and shift with the changing courses of the vessel.

This induced magnetism has been dwelt upon at some length because of its prime importance to navigation.

The other magnetic qualities of a ship are comparatively stable, but this is treacherous and changeable to a degree that necessitates constant vigilance to prevent disaster. On the great fleet of transatlantic steamers it is more likely to lead into danger than on other routes: the ships steer a generally easterly course going to Europe, and a westerly one coming to New York; the magnetic influence on the outward trip is the opposite of that returning; the ships run at a high rate of speed, and the induction varies on different parts of the route, according to the intensity of the magnetic field passed over, the smoothness or roughness of the sea which affects the motion of the ship, and the warmth or coolness of the weather.

Instead of attributing the loss of vessels when approaching a coast to the magnetic effects of fogs and land, and other improbable influences upon the compass, it were much more reasonable to ascribe it to the changed conditions of her magnetism by *induction* during the passage, and which has not been discovered or kept account of by frequent azimuths previous to closing in with the land. Suddenly, a course the captain thought perfectly safe carries the ship upon a shoal or rock, and the fault is laid upon the compasses, whereas they but obeyed the magnetic influences that became altered, during a long passage, from what these influences were when the ship was last swung to determine the deviations of her compasses.

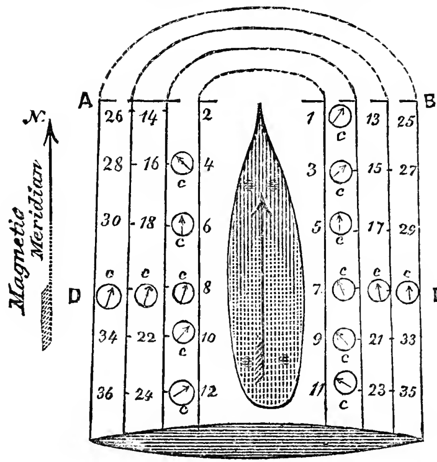
To illustrate the varied location of the poles and neutral line in an iron ship while building, Figs. 9 to 12 are drawn from actual cases. Imagine the ship cut in two by a vertical fore-and-aft plane, and both sections opened out from aft as if turned upon a hinge joining them at the bow; the outside of each half will then appear as on the paper. In Fig. 9, where the ship has been built head north, the whole upper after-body is pervaded by south polarity, while the lower forward portion has north polarity. In Fig. 10, where the ship was built head south, the whole upper forward body has south magnetism, and the lower after-body north magnetism—a condition of induction the opposite of Fig. 9. In Fig. 11, where the ship was built head northwest, we find the general magnetic features of a ship built head north, only that now the north magnetism predominates on the starboard side, and south magnetism on the port side. Finally, in Fig. 12, ship's head south-west, we have the general features of the ship's head south, but with the neutral line taking a more horizontal trend, and the south



Figs. 9, 10, 11, and 12.—The Varied Magnetic Features of Iron Ships, due to the Direction of their Heads while building.

polarity lessened on the starboard side and increased on the port side. And all the above is in close conformity to what theory requires.

The means taken for discovering the permanent magnetic character a ship has acquired in building, are a dock-survey, shown in Figs. 13 and 14. To simplify the explanation, let us suppose the ship and dock to lie parallel to the magnetic meridian. Stations numbered 1, 2, 3, etc., are established on the different steps of the dock, and the distance that each is from the line *A, B* and also from the ship's side is measured. A compass is taken successively to each station, and the direction in which its needle points is noted. Of course, if no disturbing mass were near, it would point to the north at every station. But an iron ship is there: so at station 1 we find the north end of the needle repelled from the vessel; the same occurs at stations 3, 4, 16, and many others from bow to keel around the forward body of the ship. Now, only *north* magnetism can produce this kind of deflection: it varies in degree at each station, and where greatest there is its pole. Again: at stations 7, 8, 9, etc., we find the needle's north end attracted toward the ship; hence we have discovered the body of



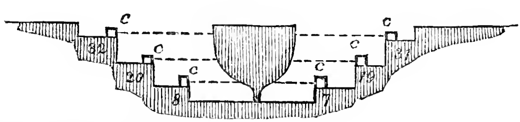


FIG. 13.—PLAN OF A DRY-DOCK WITH A SHIP IN IT.
FIG. 14.—VERTICAL SECTION OF SHIP AND DOCK THROUGH THE LINE *D D* OF FIG. 13.

south magnetism, for that alone can produce this phenomenon, and as with the other, so here, we locate its pole where the deflection is greatest. Finally, at stations 5, 6, etc., in an irregular path from bottom to rail we see that the needle points everywhere to the north: this is the *neutral line*. A sketch of each side of the ship is drawn on paper, and the degree of deflection at every station is plotted by means of the measurements from the line *A, B* and from the ship's side.

It has thus been shown that it is a huge magnet, the SHIP, that is guided around an enormous magnet, the EARTH, by a tiny magnet, the NEEDLE.

The near approach of one magnet to another always excites contention and confusion in the field they occupy, and eventually the old, old story is told—the strongest alone survives. In order that the powerful ship may not paralyze its little guide, great care is taken to find a suitable place for it; and on every voyage, ceaselessly and without fail, a variety of observations have to be made and corrections applied to the courses indicated by the compass, that this may fulfill the object of its being. To explain how this is done would involve a mass of mathematical formulæ and astronomical and magnetical information that would but tire the general reader, besides being out of keeping with the character of this article. Let it suffice to state the problem in popular phrase; to solve it would necessitate the use of other language.

An iron ship—frames, plating, decks, beams, stanchions, carlings, engines, smoke-pipes, yards, masts, shafts, armament in a ship-of-war, and numberless other parts—is not like the steel bar, a simple magnet, but a network of magnetic entanglement; yet, how complex soever this may be, for the purpose of investigation, to the end that proper means may be devised for coping with it, its influence may be considered as taking place in three co-ordinate axes, namely, fore-and-aft, athwart-ships, and vertically downward, with the compass-pivot as the origin. To facilitate this conception, let us contemplate Fig. 15, and let T represent a bar of iron of such quality that when held upright it becomes instantly magnetic through the induction of terrestrial magnetism, and as instantly has its polarity reversed upon turning it end for end; in other words, what, in investigations of this kind, is technically known as *soft* iron.

Let this bar, supposed to be anywhere in the interior structure of the ship, take the most general position possible, namely, inclined to the plane of the deck, and also to that passing vertically through the keel.

As already stated, reciprocal action occurs between the magnetism of the bar and that of the compass-needle; the upper end of the former (in this hemisphere) attracts the north end of the needle and repels its south end, while, at the same time, the lower end of the bar repels the north end of the needle and attracts its south end. The difference in distance, however, between the near ends of the bar and needle and their remote ends, enters to such extent that the influence of the remote only modifies, not equals, that of the near ends; the net result may be stated as one of action between the near ends only.

We have thus to deal with but one kind of the bar's polarity; represent its force by a line of definite length, $S\ T$ for example.

This force is resolvable into two others, the horizontal $S\ H$, and the vertical $S\ Z$; and the former is further divisible into $S\ B$, parallel to the midship line, and $B\ H$, transverse to it.

The magnetic power of the bar is thus resolved parallel to the

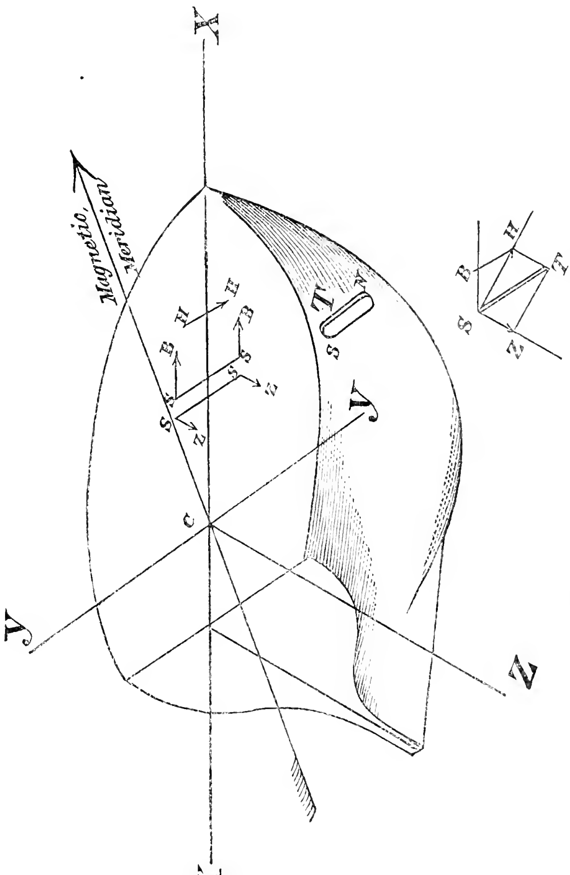


Fig. 15.—The Magnetic Forces of a Ship concentrated in Three Planes.

three co-ordinate axes. Almost all the structural iron of the ship —beams, knees, engines, boilers, etc.—is symmetrically arranged with reference to the vertical plane through the keel; so that for a piece T, on the starboard side, we should generally find another similarly disposed on the port side.

The problem is now simplified to pairs of parallel forces, each pair having its resultant parallel to one of the co-ordinate axes; *and the effect of every magnetic particle. whether of permanent or transitory magnetism, may be reduced to this condition,* We may now with facility transfer into each co-ordinate axis the sum total of all the forces parallel to it, and concentrate the whole upon the north point of the compass, whence the final result, that we have reduced the entire magnetic power of the ship to that of three imaginary magnets—one laid horizontally in the axis of X; the second, also horizontal, in the axis of Y; and the third, vertical, in the axis of Z.

The individual and combined effect of these three imaginary magnets is the object of investigation; but, before entering upon it, it will be necessary to remark that each is not simple, but complex, and that, recognizing this, we shall have to consider *all* the component parts, leaving to every *real* case to determine which of the components reduce to zero, and which are prime factors.

The iron of a ship is of varied quality, from the "hard," which when hammered acquires and keeps its magnetism, to the "soft," which has absolutely no retentive power. It occupies every conceivable direction—vertical, longitudinal, transverse, and inclined at diverse angles; but, however varied the latter, it may be represented in the first three directions by pieces of equivalent effect. Finally, it may be symmetrical or unsymmetrical. To cover all the conditions of the problem, we shall choose representatives of quality and direction, of symmetry and singularity, and let each assert its power in the common struggle.

Fig. 16 represents the arena of these forces; they are arrayed in lines of attack upon the compass.

P, Q, and R, represent hard iron, whose magnetism, the result of percussion, is of a permanent nature, like that of a steel bar; the hull itself of the ship is an example of this kind.

c, f, and k represent vertical soft iron; it becomes magnetic through the inductive agency of the earth's vertical force; c might represent the smoke-pipes; f, boat-davits; and k, stanchions on the deck below that on which the compass is located.

a, e, and g represent horizontal soft iron, the first and last, when in a longitudinal direction, and e, in a transverse direction; the power of this iron is derived from the inductive agency of the horizontal force of the earth; as examples of a may be cited the engines, boilers, and water-tanks; of e, a deck-beam cut amidships for a hatch or any other purpose; and of g (when below the compass), the shaft.

b, d, and h are substitutes for an isolated mass, like T, that has no counterpart on the opposite side, and they proclaim T's influ-

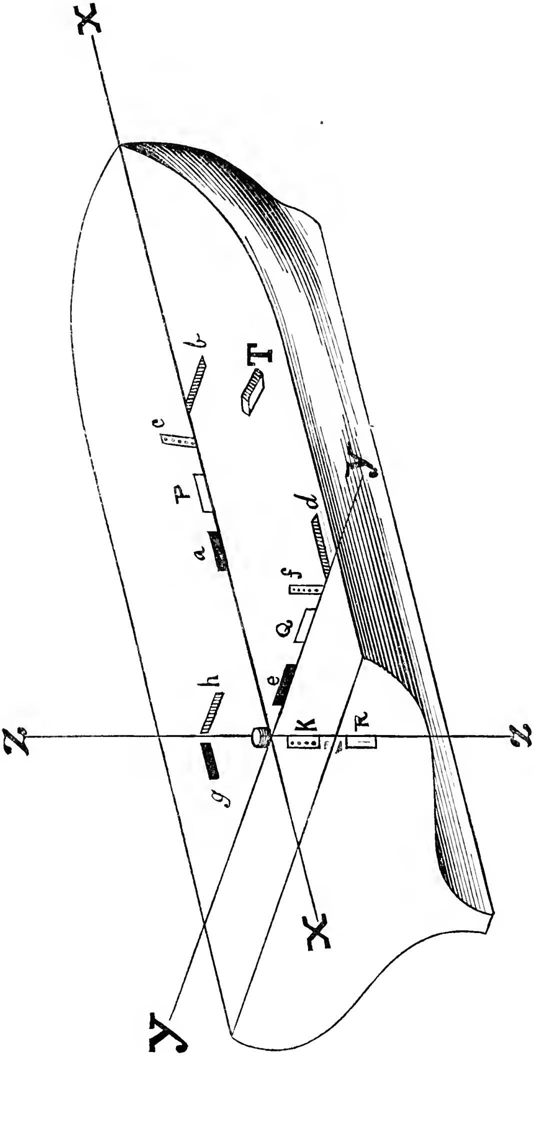


Fig. 16.—The Different Varieties of Iron in the Ship represented by Equivalent Rods.

ence in every direction to which that extends. Soft iron, and both horizontal and vertical induction, are *T's* characteristics.

In all cases of iron which becomes magnetic through the mild inductive influence of terrestrial magnetism, it should be remembered that this influence may be variously modified, if, indeed, not in some instances entirely superseded, by the inductive action of a powerful surrounding field of permanent magnetism in the hull itself.

According to the location of the bulk of each class of iron—the hard and the soft, the vertical, longitudinal, transverse, and unsymmetrical—its resultant or representative, which we may designate as a rod or a bar, will occupy a position relative to the compass, either forward or abaft, to starboard or to port; only one such position for each is shown in Fig. 16; there are, however, two possible positions for every rod, and four for some.

The problem has now been stated, so we will pursue it no further, as the vein of solution would introduce trigonometrical formulæ.

By swinging a ship at compass-buoys, or steaming in a circle on the open sea, the magnetic effect of the ship—that is, of the three imaginary magnets in the axis of *X*, *Y*, *Z*—is brought to bear at every point on the needle, causing it to deflect from the magnetic meridian by different angles at different points. These various deflections, being serially arranged, constitute what is known as "a table of deviations." Upon analyzing this, the numerical strength of each imaginary magnet is obtained, and further disintegration exposes to view their individual component parts. And thus it is that from EFFECT we seek backward to an intelligent comprehension of the CAUSE.

But as a ship sails the ocean she passes through ever-varying fields of terrestrial magnetism; also, her own magnetism is undergoing constant change, due to the wrenching and straining, the shock of waves, and the vibrations set up by firing her battery; from this mutability of cause naturally results a variety in the effect—the deviations. They are never the same.

Let a ship proceed to Havana, and she will find them different from the series determined at New York; at Hong-Kong they differ from those at Rio de Janeiro; in tropical seas they are moderate, in polar regions enormous; when a ship is upright, they have one value; when she heels, they have another. Their varying phases are a manifestation of the strife and successive domination of the three magnets whose intimate relationship has been pointed out; now it is the SHIP, as when she steers a certain course for many days and thus strengthens her forces; again, it is the EARTH, when the compass ventures into her frozen strongholds, where it but wavers sluggishly and totters about every course; and finally comes the little NEEDLE's turn—in the genial tropics, where it can point out steadily and safely the path to any port.

The necessity of frequent observations for determining corrections to be applied to the compass is, therefore, evident.

The series of total deviations is generally divided into two principal parts, the quadrantal and the semicircular: the first taking its name from the fact that it arises, reaches a maximum, and again reduces to zero, all within an angular space of 90°; and the second, for a similar reason, because of its origin, growth, and decline being confined to 180° of the circle.

Frequently, means are provided for opposing the magnetism of the ship by other powerful magnets, thus permitting the needle

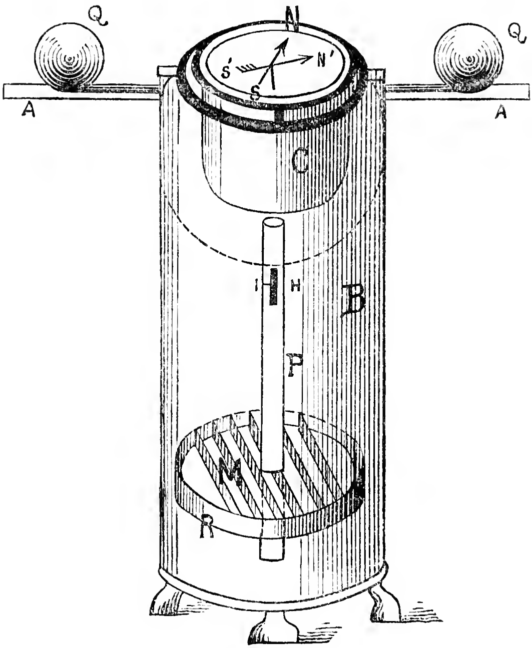


FIG. 17.—THE COMPENSATING BINNACLE.

to point in its natural direction, however the ship may head, Such a contrivance is known as a compensating binnacle, shown in Fig. 17. Before compensation, let the needle point in the direction *N′ S.′* A portion of this deflection is the quadrantal deviation, due to the soft iron in the ship; it is overcome by placing two large cast-iron spheres, *Q* and *Q,′* at suitable distances from the compass; the other portion of the deflection being due to the hard iron (that is, the semicircular deviation), a number of steel bar-magnets, *M*, are placed in a disk, which is turned to the requisite angle and then raised or lowered, until the needle returns to the magnetic meridian *N S*. The magnet *H*, to nullify the heeling deviation, is placed at a predetermined distance vertically below the compass-pivot.

In considerable changes of magnetic latitude the magnets have to be slightly moved to counterbalance the altered condition of the deviations, and sometimes, also, to correspond to a partial loss of power in the magnets themselves.

HOUSE-DRAINAGE FROM VARIOUS POINTS OF VIEW.

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IN the year 1596 there was published in London a pamphlet entitled "A new discourse of a stale subject; called the Metamorphosis of Ajax. Written by Misacmos," which was followed in the same year by a second pamphlet entitled "An Anatomy of the Metamorpho-sed Ajax, wherein, by a tripartite method, is plainly, openly and demonstratively declared, explained and eliquidated by Pen, Plot, and Precept, how unsavory places may be made sweet, noisome places made wholesome, filthy places made cleanly. Published for the common benefit of builders, housekeepers, and house owners, by T. C., traveller, apprentise in poetry, practiser in music," etc.

The titles of these little books were in the style of the age in which they appeared; but the contents were something new, for they contain the first description and illustrations of a water-closet which had appeared since the days of old Rome. They contain a good deal more, it is true; for the author, Sir John Harrington, made them the medium of a Rabelaisian satire upon things in general, and his own times in particular, which was of such a character that license to print was refused, and Queen Elizabeth, who was not prudish, forbade the author from appearing at court. His reasons for his device are interesting: "For when I have found, not only in mine own poor confused cottage, but even in the goodliest and stateliest palaces of this realm, notwithstanding all our provisions of vaults, of sluices, of grates, of pains of poor folks in sweeping and scouring, yet still this same whoreson saucy stink, though he were commanded on pain of death not to come within the gates yet would prease to the chambers; I began to conceive such a malice against all the race of him that I vowed to be at deadly feud with them till I had brought some of the chiefest of them to utter confusion, and conferring some principles of philosophy I had read, and some conveyances of architecture I had seen, with some devices of others I had heard, and some practices of mine own I had paid for, I found out this way that is after described, and a marvellous easy and cheap way it is.

"Here is the same, all put together; that the workman may see if it be well. A, the cistern; *b*, the little washer; *c*, the waste pipe; D, the seat board; *e*, the pipe that comes from the cistern; *f*, the screw; *g*, the scallop shell, to cover it when it is shut down; H, the stool pot; *i*, the stopple; *k*, the current; *l*, the sluice; *m*, N, the vault into which it falls; always remember that the servant at noon and at night empty it, and leave it half a foot deep in fair water."

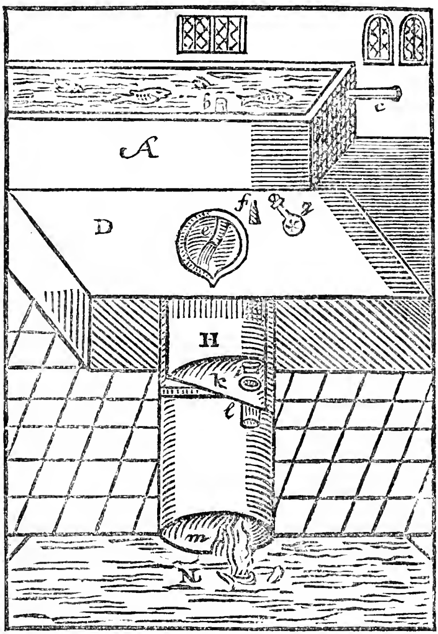

Fig. 1.

It seems a long stride from Sir John Harrington's pet contrivance to the complicated fittings of a water-closet in a modern city house built under existing regulations; but the evolution has, upon the whole, been through complications toward simplicity, as will be seen by Fig. 2, which represents a good form of closet of the present day, and the most important improvements in house-drainage have been made within the last twenty years. We can now say that, so far as the plumbing fixtures in the dwelling-house itself are concerned, freedom from nuisance and a sufficient degree of safety can be secured at a reasonable cost; provided that trustworthy workmen are employed in the construction of the work, and that the apparatus is properly managed and cared for. Several phrases in this sentence will bear a little amplification.

In the first place, it must be clearly understood that the fixtures and pipes which form an individual system of house-drainage are only a part of the apparatus required for the disposal of offensive and dangerous refuse. Their external connections are

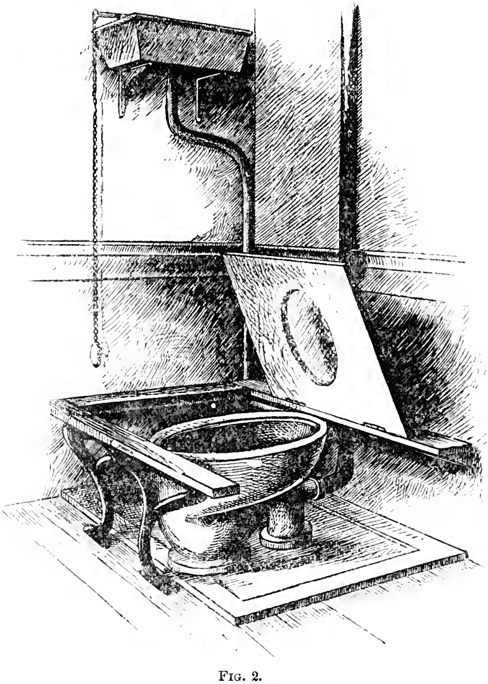

Fig. 2.

an important part of this system, and, according to whether these be with cess-pools or sewers, or whether these last are isolated or are connected with many other houses, will depend the perfection of the results obtained. In this article the house-drains and fixtures only will be considered.

Secondly, what is a "sufficient degree of safety"? Absolute safety can not be guaranteed by any system. If we can so arrange the plumbing that, so far as it is concerned, the air in the house shall be as pure and as free from specific causes of disease as the air in the streets, it is the best that can be done. Reasonable cost refers to that which is essential, and not to that which is for ornament or luxury; it varies greatly according to the style of house, the essential point being that it shall furnish the means of getting rid of excreta and of water fouled by domestic use, without danger to the health of the inmates of the house.

What, then, are the dangers to health from defective plumbing? They are due to gases or to micro-organisms coming from defective fixtures, joints, or pipe, or from soil pollution due to such defects. The gases in question are, for the most part, products of the decomposition of organic matter of animal origin, and the types are carbonic acid, ammonia and its compounds, and sulphureted hydrogen. There are also produced certain effluvia, of the precise nature of which little is known; the most common is that giving a faint, sweetish, peculiar odor, resembling that of boiled turnips.

These gases and odors do not produce specific disease, but when they are distinctly present in a house the inmates are liable to be affected with various forms of disturbed digestion, loss of appetite, slight headache, and a depressed state of vitality. How far these are due to the gases themselves and how far to the micro-organisms present under such circumstances we do not yet know. The majority of persons gradually become so accustomed to their effects that they can live and work with little or no apparent inconvenience in an atmosphere which is so charged with them as to be not only offensive, but really dangerous to those accustomed to pure air only. Plumbers, scavengers, workers in sewers and at sewage-works, or in bone-boiling establishments, etc., prove this; but it must be remembered that these are survivors, and that a certain number who begin these occupations soon find it necessary to go into some other business. Upon the whole, the dangers from gases only in connection with house-drainage are small, and comparatively easy to avoid, the main thing for this purpose being a complete and constant ventilation of the pipes.

In part the dangers are due to extremely minute particles of living matter, most if not all of which are vegetable organisms known as bacteria. There are many different kinds of bacteria, and they have very different properties and powers, but those which concern us in this connection are those which grow and multiply in decomposing organic matters, and especially in excreta. Almost without exception these bacteria belong to species which are found in the air of streets, in all intestinal discharges, and in all putrefying matters; they are not only harmless under all ordinary circumstances, but are highly useful in decomposing dead organic matter into simple compounds available for the nutrition of plants. They are found in countless numbers in the slimy, pulpy layer of decomposing matter lining the interior of soil-pipes, which matter they are constantly decomposing into gases and soluble products readily washed away. They are also present in large quantities in sewage as it flows in the sewers.

There are a few forms of bacteria which we have good reason to believe are the causes of certain diseases called specific. Each of these specific diseases has a definite course, and is due to the entrance into the body of particles of living matter derived, directly or indirectly, from the body of a person affected with the same disease.

We now know the particular kinds of bacteria which cause several of these diseases, and can identify them with considerable certainty. Those of most interest in connection with house-drainage are those which are supposed to cause suppuration, septicæmia, puerperal fever, erysipelas, intestinal irritation and diarrhœa, typhoid fever, and sore throats and diphtheria.

These diseases are less frequent and less fatal in sewered than in unsewered cities, and in the central sewered portion of a city than in the unsewered suburbs. Systematic house-to-house inspections in cities have shown that over one half of the houses have more or less defective and foul fixtures and leaky soil-pipe joints, so that if specific germs are often present there should be much more sickness than there is. As a matter of fact there is no evidence that scarlet fever, measles, small-pox, or whooping-cough has ever been transmitted by sewer air. There is reason to think that in a few and exceptional cases diphtheria and typhoid have been caused by inhaling sewer or soil-pipe air; but the danger of incurring these diseases in this way is small as compared with the other and usual sources of origin, although it is probable that the ordinary non-specific sore throats which sewer air tends to produce form a specially favorable site for the development of the specific microbe of diphtheria, and that in this way foul air is a predisposing cause of this disease. Schools are much more dangerous than sewers as regards the propagation of diphtheria.

The typhoid-fever bacillus is said to have been found in the air of a sewer from an institution in which there was an epidemic of typhoid, and there is a theoretical possibility that the disease might thus be produced in a house by conveyance of its germs through sewer and soil-pipe air; but such conveyance must be extremely rare. It should be distinctly understood that neither the most perfect system of house-drainage nor total absence of house-drainage will protect the inmates of the house to any considerable extent from diphtheria or from typhoid.

The most dangerous micro-organisms which are commonly found in sewer and soil-pipe air are those which produce suppuration, erysipelas, or septic poisoning when they gain access to the interior of the body through a wound of any kind; although they may be inhaled or swallowed with comparative impunity. These are especially dangerous to new-born infants and to lying-in women, as well as to wounded persons. From my personal experience I should say that the forms of disease most frequently produced by sewer and soil-pipe air with its contained bacteria are slight inflammations of the throat, tonsillitis, and mild diarrhœal troubles.

It will be seen, therefore, that while attempts to scare people by depicting the horrors of sewer-gas, etc., in order to prevent the construction of sewers, to promote the sale of certain fixtures, or to improve the house-inspection business are not justifiable, it is certainly true that, upon ordinary insurance principles, it is wise to prevent as far as possible the entrance of sewer and soil-pipe air into dwelling-houses, offices, hospitals, and public buildings; and that a municipality is justified in taking measures to secure such prevention for those who are too ignorant, too indifferent, or too helpless to do it for themselves.

To provide, in an ordinary dwelling-house, a system of pipes and fixtures though which will quickly pass away all excreta and water rendered foul by use in closets, sinks, wash-basins, baths, etc., while the passage of gases and odors from the pipes into the house is prevented, and liability to obstruction of the pipes is as small as possible, is not now a very difficult matter under ordinary circumstances.

The differences of opinion as to the best modes of doing this, which are found in the writings of sanitarians, sanitary engineers, plumbers, etc., and which appear so confusing to one who is not familiar with the subject, are largely due to the fact that the different writers and speakers consider the matter from very different points of view; and it may be well, therefore, to refer to some of these which have the greatest influence in determining opinions.

The first point of view to be considered is that of the man who proposes to build a house for his own family, and who wants to know how he can secure, at a reasonable cost, a convenient and safe system for the removal of excreta and wastes.

If he employs an architect to prepare the plans and specifications for his house, the first suggestion would naturally be that the same architect should prepare the plans and specifications for the plumbing. It is, however, asserted by sanitary inspectors, physicians, plumbers, and popular writers, that architects do not, as a rule, furnish proper plans and specifications for house-drainage; that many of them are not competent to do it, and the rest will not take the trouble; and that to make sure of good results an expert in this particular line must be called in.

The first part of this charge, viz., that architects do not, as a rule, furnish proper plans and specifications for the plumber's work in the houses which they design, is true. They indicate upon the floor plans the positions of sinks, bath-tubs, and water-closets, and specify that the plumber's work must be done to the satisfaction of the architect, possibly stating the particular form of sink or closet that is to be furnished, especially if this has been dictated by their clients. They do not, as a rule, show the pipe-work in section or elevation. A proper set of working drawings for the plumbing of a house, upon which bids are to be made and the responsibility for plan and workmanship is to rest, and which is to be preserved as a guide for future work in changes and repairs, should be almost as minute in detail as the working drawings for the stairways or carved work. These plans and sections should show every pipe, fixture, joint, stop-cock, and trap, in their relations to walls, timbers, floors, gas and steam pipes, and ventilating flues, and give their dimensions. From these plans and specifications a competent plumber should be able, not only to make out a complete list of every length and size of pipe, trap, hanger, and fitting that he will need, but to do a considerable part of the work in his shop and deliver it ready to put in place. It must be admitted that such plans and specifications are rarely prepared, and that when they are furnished they are rarely made in the office of the architect. I do not think, however, that this fact is due so much to the inability of architects to make such drawings and specifications, as to the fact that they are unwilling to take the time and trouble to prepare them unless they are specifically demanded by their clients; thinking that any good plumber will be able to settle all the details of the work if the general scheme is only indicated, and that detailed working drawings are an unnecessary expense. Certainly the course of instruction in our schools for the systematic education of architects includes enough to enable the graduates of such schools to do this kind of work, although it may be doubted whether actual practice in the preparation of such drawings and specifications is sufficiently insisted on as compared with that required in the designing of façades and ornamental carving.

It is wise for the man who proposes to build a house to insist upon having detailed drawings and specifications for the plumbing-work, even if he does not employ an architect; the cost of obtaining them will be saved twice over in the first ten years after the building is completed, and this independent of the influence of the work on the health of the inmates. The drawings should not be folded up and put away, but should be neatly framed under glass and hung in the bath-room in a good light. The general principles to be observed in preparing such plans to obtain the greatest freedom from nuisance, security to health, permanence of satisfactory performance, and ease and cheapness of inspection and repair, are as follows:

1. Have no more fixtures and pipes than are really necessary, and have all the fixtures as close to the soil-pipes as possible. Do not put fixed wash-basins in any sleeping-room, nor any fixture in such a position that its outlet-pipe must run horizontally, or nearly so, beneath the floor for a distance of more than ten feet before it discharges into the soil-pipe.

2. Avoid, as far as possible, the placing of fixtures in the basement or cellar of the house. In a house properly constructed from a sanitary point of view, the basement or cellar should be entirely given up to heating and ventilating arrangements and to storage, and should not contain either kitchen, laundry, sinks, or closets. All the pipes for drainage, water, gas, etc., should be plainly visible and readily accessible on the ceilings or walls of this lower story, and this can not be effected if kitchen-sinks or laundry-tubs are placed on the lowest floor. This advice can not be followed in many cases because of the expense; but it should be the rule for all houses costing twenty-five thousand dollars and upward.

3. Soil-pipes should be of cast-iron, of the kind known as extra heavy, and, for an ordinary dwelling-house, should be four inches in diameter, weighing about thirteen pounds per foot run. If the soil-pipe must be carried beneath the floor of the cellar or basement, it should be either bedded in cement or put in a brick trench with a removable cover. Every joint in a soil-pipe should be so made that it will not leak when the pipe is filled with water to a height of ten feet above the joint.

4. Provision must be made for the constant passage of a current of air through the soil-pipe from the bottom to the top, and it should have no dead ends. For this purpose it is necessary that the soil-pipe should pass up through the roof and be freely open at the top. It must not be diminished in size above the highest fixture; on the contrary, it is better that it should be slightly enlarged, so that a four-inch pipe may properly be connected with a five-inch pipe above the upper fixture. That part of the soil-pipe above the upper fixture should be of as good material and have the joints as carefully made as that below.

5. In order that a current of air shall pass through the soil-pipe, it must have an opening connected with the air below as well as above. Should this air which is to pass up through the soil-pipe be taken from the sewer, or from the air of the street? In other words, should there be a trap in the soil-pipe between the house and the sewer, with a fresh-air inlet between the trap and the house, or should the trap be omitted and the sewer be venti-

lated directly through the soil-pipes to the tops of the houses? The reply to this is, that where there are properly constructed self-cleansing sewers, having no cess-pool connections, and the house connections of which are made under the control of the engineer having charge of the sewers, it is well to omit the trap between house and sewer, and let the latter ventilate directly through the soil-pipes; but exception should be made to this where the top of a soil-pipe would be on a level with or below the windows of inhabited rooms in a neighboring house. When the house-drains are connected with a cess-pool, or with a sewer presenting the characters of a cess-pool, it is safer to insert the trap; in which case there should always be a fresh-air opening between the trap and the house. If the pipes and fixtures in a house are properly arranged, and the joints are all tight, there is very little risk to the inhabitants of the house itself in having a direct connection with an ordinary sewer without a trap; the danger really being to the inhabitants of neighboring houses. On the other hand, if the trap between the sewer and the house be properly inserted, it creates no risk of danger or nuisance in the house to which it is applied, and costs little. The argument that it checks discharges from the house and tends to produce deposit in the horizontal part of the soil-pipes next to it on the

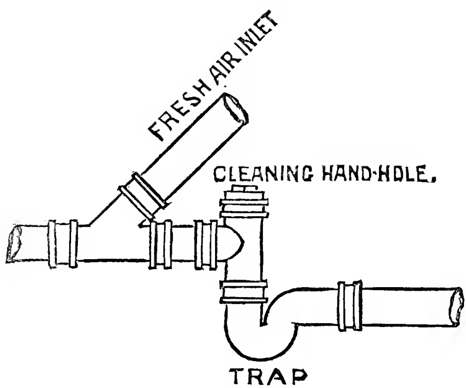

FIG. 3.

house side, is unsound if this part of the pipe has a proper fall and the top of the trap is six inches below the pipe; for I have examined pipes which had been twelve years in use under such circumstances, and found no deposit worth speaking of. A proper form of trap between house and sewer, with fresh-air inlet, is shown in Fig 3. The question is of more importance taken in connection with the ventilation of sewers by street openings as affecting the comfort and health of the community generally than it is to the individual householder.

6. The incasing of fixtures in wood should be avoided as far as possible. The best bath-tubs and wash-basins are those in which the overflow is through a stand-pipe which is lifted to discharge the water, thus avoiding side or end overflows. The best closets are wash-out, short-hopper or siphon-jet closets. Every closet should have its own cistern, and the flushing-pipe from the cistern should be not less than one and a half inch in diameter. Housemaids' sinks should have a flushing rim and a separate cistern. Fixed laundry-tubs should never be made of wood. Urinals in a private house are usually an unnecessary nuisance; if put in, they must be cleansed frequently by rubbing. It is better that fixtures should be opposite windows than against outer walls, to avoid dark places beneath and around them, and to prevent danger of freezing the pipes.

7. To prevent the passage of soil-pipe and sewer gases, with their suspended micro-organisms, through the fixtures into the house, some form of trap must be used, and this should always be placed as close as possible to the fixture which it is to guard. The best form of trap under all ordinary circumstances is a water-trap made by a bend in the pipe, forming what are known to all plumbers as S or half-S traps. Such a trap, so long as it preserves its water-seal, affords ample protection against both gases and bacteria, and, in ordinary dwelling-houses, it is easily protected against the loss of its seal by evaporation or by siphonage. If a fixture remains unused for several months, its trap will become unsealed by evaporation. In the trap to the outlet-pipe from an ordinary wash-basin this will occur in about two months if the trap is not ventilated, and in about two weeks if it is ventilated. This will be referred to again in speaking of the care of house-drainage. As regards siphonage, the proper ventilation of the traps is a sufficient protection in all ordinary habitations of three or four stories. The ventilation of traps is not, however, solely for the prevention of siphonage; it is of equal if not greater importance to secure a current of air through all parts of the pipes so as to promote the constant oxidation and removal of the slime which lines all pipes devoted to house-drainage. The immediate agents which produce this oxidation or slow burning of the organic matter which smears the interior of the pipes are those bacteria which are called aërobic, because they flourish best where there is plenty of oxygen. These are Nature's scavengers; the great majority of them are not dangerous to health, but rather tend to destroy or starve out the really dangerous specific forms. They convert the soil-pipe slime into gases and soluble products, which products are washed away by the next flush of water; and

they should be given a fair chance to do their work by giving them plenty of air. Where a closet is only three or four feet from the soil-pipe, this ventilation is not necessary for keeping the pipe clear; but it is more than ever necessary to prevent siphonage. It is only under such circumstances that I would use a trap specially difficult to siphon and without ventilation; but such a trap should be cleansed every six months, for a trap which will not siphon will collect filth.

8. Whether the work be for construction or for repair, see that skilled workmen are employed upon it. There is little difficulty in finding in any large city a plumber who understands his business and takes pride in doing good work. He probably will not compete for contracts, and his prices may be from twenty to fifty per cent higher than some other plumbers will demand; but it is wisest to employ the best men, accept their advice, and not grumble about their bills. A competent sanitary engineer, by which is meant a well-educated engineer who has made a special study of water-supply, sewerage, house-drainage, etc., will make the best drawings and specifications, but first-class workmen are required to carry these out; and a class of plumbers is slowly being developed who can make plans and specifications satisfactorily, and whose advice as to fixtures, etc., can be relied upon, and such men should be sought for and employed, no matter what their prices may be.

House-drainage may also be considered from the point of view of the man who wants to know whether the plumbing actually in his house is in such condition that it is or is not worth while for him to make changes or repairs in it. It may not be such a system as he would put in if he were building a new residence; but he does not wish to incur more expense connected with it than is absolutely necessary. If no offensive odors have been perceived, and there has been no sickness in the house which would give rise to a suspicion that the drains might be out of order, he will usually be satisfied, and will not even take the trouble to carefully examine the apparatus, and still less will he be disposed to have it inspected and tested by an expert. If offensive odors are perceived in the house, and cases of disease occurring in it have roused suspicion in his mind, he will probably be more inquisitive; and, if the physician advises skilled inspection, he will usually be willing to have this made. The essential points to be determined by such an inspection are, first, whether there is leakage from any part of the soil-pipe beneath the cellar or basement; second, whether there is any obstruction to the flow of sewage to the sewer; third, whether there is any leakage of gas into the house from any joint or fixture; and, fourth, whether the soil-pipe is properly ventilated and the traps properly arranged. There are many other details which the inspector will examine; but it is not the object of this paper to describe his work. To determine the points above mentioned the inspector will wish, first, to plug the soil-pipe between the house and the sewer, so that he can fill with water that part of the pipe beneath the cellar-floor, and thus determine whether there are leakage and probable soil pollution, which will necessitate the opening of the floor to find the leak. Next, he will wish to test the vertical part of the soil-pipe, connecting-pipes, and fixtures for gas leakage, by blowing into the pipe from below either smoke or sulphurous-acid gas, or by pouring in oil of peppermint from above. Often leaky joints, damaged fixtures, etc., can be found by mere inspection; but often, also, some such special tests as those indicated above are desirable. The inspector will also wish to know precisely where all the pipes and traps of the house-drainage are, how they are connected, and what are their sizes. If the householder can show him a plan giving this information, it is well; but if not, he may have to prepare one for himself, and for this purpose to take up floors, cut into the walls, etc.

Every house-owner should have such a plan, just as he should have a record of title; and every one who hires a house will act wisely in examining such a plan before signing his lease. The proper time for obtaining this plan is when the drainage system is put in the house. This brings us to a brief consideration of a fourth point of view of house-drainage, viz., that of the sanitary authorities, or officials charged with the duty of seeing that individual premises do not become nuisances or injurious to the public health. Most of our large cities now have regulations with regard to house-drainage and sewer connection, based upon the following principles, viz.: 1. That a man must so use his property that it shall not be a source of offense or injury to others. 2. That the condition of sewers depends, to a considerable extent, on the character and condition of the sewage discharged into them, and that the municipality which is charged with the construction and maintenance of a common system of sewers has the right to regulate, within certain limits, what shall be turned into them. If cess-pool overflows, and sewage from long horizontal reaches of pipe, are turned into the sewer, it must contain putrid sewage; and it will be correspondingly difficult to ventilate it and keep it in proper condition. 3. That the arrangements for house-drainage are intimately connected with those of house water-supply; and that where the municipality furnishes a general water-supply, it has the right to make regulations and inspections to prevent waste and to see that it is properly used.

Municipal regulations for house-drainage vary somewhat in different cities; but in general they provide that, for all new work, copies of the plans and specifications must be filed at a central office, and be approved by some competent person; that the work as it progresses, or when completed, must be inspected by a municipal officer, and that there shall be a register of those plumbers who are considered competent to do such work.

Usually also there is provision for the inspection of the plumbing of any house when there is reason to suspect that it is in a dangerous condition, or upon the application of the owner or tenant. It is common to require the ventilation of soil-pipes and traps, the trap between the sewer and the house, and the fresh-air inlet, and that all soil-pipes within the house, whether vertical or horizontal, shall be of iron. These regulations are not approved by certain manufacturers and patentees, who find that they conflict with their interests; but upon the whole it is best to allow the municipal health authorities to settle these questions, rather than to have them controlled by trade interests, and it is better to have the rules uniform, and leave as little as possible to the discretion of the officials, even though, in a few cases, this may lead to the putting in of a trap or ventilating-pipe which is not absolutely essential.

The first municipal Board of Health to carefully investigate the subject of defective house-drainage, and to issue instructions and regulations with regard to it, was the Metropolitan Board of Health of New York city under the presidency of Prof. C. F. Chandler, of Columbia College, from 1875 to 1883. To meet the requirements of the board, manufacturers rapidly produced new and improved forms of fixtures, a registration of plumbers was established by law, and the rules and regulations of New York city have practically been the model for those of other cities.

There is still another point of view to which brief reference may be made, viz., that of a man who has a pecuniary interest in certain forms of apparatus, closets, traps, etc., which he wishes to have introduced as extensively as possible. He does not approve of municipal or other regulations which make the use of his appliances difficult or expensive, and he will look favorably on those rules which require the use of his apparatus or its equivalent. It is not to be expected that he will advocate the use of new forms of apparatus, unless, indeed, he owns the patent for them, or has introduced them himself; yet this does not necessarily follow, and still less is it to be assumed that, because a man seeks to promote his pecuniary interests, his arguments and propositions are necessarily unsound, and to be condemned.

Professional men, such as physicians, architects, and engineers, do not, as a rule, look favorably upon the taking out of patents connected with their special work. This is formulated in the code of ethics of physicans in the statement that "it is derogatory to professional character for a physician to hold a patent for any surgical instrument or medicine." Much the same feeling exists with regard to patenting or otherwise attempting to obtain exclusive control of means for preventing disease, for supplying fresh air or pure water, for disinfection, or for the removal of the foul and dangerous substances necessarily produced by human beings in daily life; and, while the physician, the architect, or the engineer may make use of patent ventilators, filters, traps, or closets, purchasing them as manufactured articles, because they will serve the purpose, and it is easier and cheaper to buy them than to make original designs, yet they avoid giving certificates or recommendations in favor of any such patented article, and distrust those who do so. I state this as a fact, without discussing the question as to whether it is right or wrong, wise or unwise; it is given merely as one reason why in this paper I do not discuss the merits of particular forms of patented appliances for house-drainage, since it is sufficient for my purpose to show that convenience, cleanliness, and safety can be secured without the use of any particular form or piece of apparatus. At the same time it should be distinctly understood that I do not condemn all such patents or patented articles. On the contrary, I believe that the improvements which have been made in house-drainage during the last twenty-five years have been due, to a considerable extent, to the competition of business interests, urged on and directed by scientific investigations made by men who would themselves have never patented an appliance or engaged in its manufacture.

It is to be remembered that, when a system of house-drainage has been made satisfactory, it will not remain so unless it is properly used and looked after. Rust and grease will tend to obstruct the pipes, the tops of lead bends will corrode, cloths and rubbish will be thrown into the fixtures, fresh-air inlets will become plugged by snow or mud, the open top of the soil-pipe may be closed by accumulated ice. One of the most frequent dangers arising from want of care is that which results from leaving the apparatus unused for several weeks or months, as when the family shuts up the house for the summer and goes to some health resort. In a few weeks, sometimes in two weeks, the water in the traps so far evaporates that they are unsealed, and then follows a stream of air into the house, bearing with it micro-organisms which gradually settle in the layer of fine dust which gathers on floors, shelves, ledges over doors, gas-fixtures, etc. If, now, the family returns and occupies the house, using only the ordinary processes of sweeping, dusting, etc., which do not destroy the germs but merely scatter them about, there is serious danger of sickness. On leaving a house in this way, arrangements should be made to have every fixture in it flushed at least once a week (once in three days is better), and, if it be necessary to move into a house which has been for some time unoccupied, and where you are not sure that these precautions have been observed, then thorough cleansing with cloths wetted with disinfectant solutions should be employed as a matter of ordinary prudence, and this should be applied to every exposed surface.

If the system of house-drainage is properly arranged, and the plans above referred to are at hand, its inspection is a simple matter, and should be made at least once in three years.

Finally, the art of plumbing is not to be learned from books or magazine articles. A man may be M. D., D. D., or LL. D., and be densely ignorant about house-drainage, or as to whether that of his own house is in good condition or not. Every housekeeper ought to be familiar with the pipe plans for her own house, and know just how to turn the water off from any given riser; beyond that, the truest wisdom is to be aware of one's own ignorance, and to get skilled advice whenever advice is needed.

TOWN-LIFE AS A CAUSE OF DEGENERACY.*

By G. B. BARRON, M. D.

IT may be readily supposed that the conditions of life and their general surroundings must largely influence and materially affect the physical or constitutional characteristics of town-dwellers. At the onset, then, I venture to advance the proposition that the "vital force" of the town-dweller is inferior to the "vital force" of the countryman. The evidence of this is to be found in a variety of ways. The general unfitness and incapability of the dwellers in our large hives of industry to undergo continued violent exertion, or to sustain long endurance of fatigue, is a fact requiring little evidence to establish; nor can they tolerate the withdrawal of food under sustained physical effort for any prolonged period as compared with the dwellers in rural districts. It may be affirmed also that, through the various factors at work night and day upon the constitution of the poorer class of town-dwellers, various forms of disease are developed, of which pulmonary consumption is the most familiar, and which is doing its fatal work in a lavish and unerring fashion. Thus it may be conceded as an established fact that the townsman is, on the whole, constitutionally dwarfed in tone, and his life, man for man, shorter, weaker, and more uncertain than the countryman's. I hold the opinion that the deterioration is more in physique, as implied

* Abstract of a paper read at the British Association Meeting, Bath.

in the loss of physical or muscular power of the body, the attenuation of muscular fiber, the loss of integrity of cell-structure, and consequent liability to the invasion of disease, rather than in actual stature of inch-measurement. The true causes of this deterioration are neither very obscure nor far to seek. They are *bad air* and *bad habits.* To these may be added a prolific factor operating largely to produce degeneration of race, and that is, *frequent intermarriage*, often necessitated by religious affinities.

Taking these causes in the order in which I have placed them, but without reference to their relative intensity, I think *bad air* is a potent factor of enfeeblement. Included in the phrase "bad air" are bad sanitation and overcrowding. I have no doubt in my mind that it has a powerful and never-ceasing action, paramount and decisive, on the physical frames of young and old town-dwellers, producing deterioration of physique, lowered vitality, and constitutional decay. For over thirty years I have been hammering away at this question of "bad air" and "bad sanitation" as the prime causes of impairment of health and race, and the more I consider it the more I am convinced of the soundness of my conclusions. A great deal has been said on this subject, and it is not difficult to adduce conclusive evidence from a large variety of reliable sources in proof of the deleterious effects of impure air on the animal economy. Consumption is the best type of degenerative action and loss of vital energy. It stands out in bold relief as the disease most rife wherever foul air exists. The significance and value of fresh air were recognized by the old fathers of medicine. Hippocrates was accustomed to advise a walk in fresh air of ten or fifteen miles daily. Aretæus, Celsus, and Pliny speak of the good effect of fresh air; and our great English physician, Sydenham, did the same thing. Dr. Guy found that of 104 compositors who worked in rooms of less than 500 cubic feet of air for each person, 12·5 per cent had had spitting of blood; of 115 in rooms of from 500 to 600 cubic feet, 4·35 per cent showed signs of consumption; and in 100 who worked in rooms of more than 600 cubic feet capacity, less than two per cent had spit blood. Consumption is only one of the long list of evils to which the town-dweller is exposed. But it is not desirable to particularize all the medical features of this question; their name is legion. It may be well to mention that the Labrador fishermen and the fishermen of the Hebrides, with plenty of fresh air, are practically exempt from this disease. The absence of pure air acts upon the animal economy in much the same way as the withdrawal of light on plants, the result being pallor and feebleness of constitutional vigor. This effect ramifies in every direction; the tissues of which the human body is composed lose their tonicity and contractile power, and even mental integrity may be more or less affected.

The pent-up denizens of the courts and alleys of our large towns, surrounded on every side by imperfect light, bad air, and the general aspects of low life, necessarily degenerate in physical competency, and their offspring is of a feeble type. Fortunately, one antidote is to be found in the nomadic instincts of such offspring. Better the gutter-life and street Arab gymnastics than the sickly incapability of a pent-up cellar child. When people are huddled together in badly ventilated hovels and narrow courts, compelled to live almost without light and air, the effects are soon made clear. The unsavory courts and slums of our large towns can not but be productive of a lowered vital force and impoverished physique. The fact must not be overlooked that there are two classes of town-dwellers: one being those who dwell for a limited number of hours in the day—that is, whose occupation keeps them in close offices and places of business during the day, but who sleep in the suburbs in purer atmospheric conditions; and those who pass the whole of their lives in bad contaminated air without the advantage of a few hours' respite out of the twenty-four. It is with the latter class that my observations deal.

The second chief factor of deterioration—viz., *bad habits of life*—tells a sad story on the physical power of the town-dweller; probably through ignorance, but certainly indifference to the ordinary precepts of health is the rule of life. It is no doubt a fact that intemperance largely exists among this class, and the incidence of debauch upon them is heavier than upon those who live under more favorable conditions. Then the various forms of impurity smite with devitalizing severity the offspring to the third and fourth generations. Moreover, the general tendency of their ailments is of the asthenic type. When we add to these conditions of human existence the influence of imperfect feeding and malnutrition, we get the state of physical degeneracy largely increased and emphasized. In the paper alluded to great stress was laid upon the diet of the town-dweller, as compared with that of the countryman, as tending to degeneracy and impaired health. The digestive capability of the former is of a lower standard, and less capable of dealing with the ordinary articles of diet, than the latter. Consequently, they live on such food as they can digest without suffering—bread, fish, and meat; above all, the last. The sapid, tasty flesh of animals, which sits lightly upon the stomach, gives an acceptable feeling of satiety, so pleasant to experience. Such selection is natural and intelligible, but it is fraught with danger. I quote from the paper: "The chief diet selected by the town-dweller begets a condition known to doctors as the uric-acid diathesis, with its many morbid consequences. Pulmonary phthisis and Bright's disease seem Dame Nature's means of weeding out degenerating town-dwellers." Such are some of the medical aspects of the case. But it must not be lost sight of that there is a large class who are not able to procure much nourishing food of any kind, but, on the contrary, are forced by poverty to be content with less sustaining dietary, and they adopt another kind of food, not less injurious, but in another way—a diet mainly consisting of bread, tea, and such-like aliments. The time-honored fashion so prevalent among well-to-do people, of five-o'clock tea, may be attended with many advantages socially, but woe to those who take tea four or five times a day, and rely upon it alimentarily!

But it is not the male sex alone that we have to consider. The factors I have briefly enumerated tell a terrible story on the lives of mothers of this part of future England, and their offspring pay the penalty Nature imposes upon those who fail to fulfill her laws. Their children evidence constitutional disabilities of the frame, which is badly and slowly developed, while their mental precocity shows itself in a peculiar adroitness in all the arts of cunning acquisitiveness. It is supposed by some that the effects of mental activity thus early developed interfere with the development of the physique. No doubt the scanty necessaries of life induce a standard of craftiness and cunning which passes muster for intellect at an age which would imply precociousness and superiority, while the country child remains in its first simplicity.

But to the important question, "Is the town-dweller degenerating in stature, or is he not?" there is yet no satisfactory answer supplied. It has been said that such a thing as a pure cockney of the fourth generation is a rarity, and so it may be said of all other large towns. The immigration of country-folk of both sexes into our large towns is a well-known fact, and it is impossible to trace how far marriage supplies an admixture of new blood into the worn-out stock, and thus renovates it and becomes an antidote to decay. Taking the best evidence we possess, we can only approximately arrive at a solution of the problem. I have said that the degeneracy probably is more found in the loss of enduring tone and physical vigor than in inch-measurement. The constant and ever-recurring immigration of the strong and robust countryman into the cities constitutes a steady counterpoise to the downward tendency, and the balance is fairly well sustained. Hence the difficulty of solving the problem. Seven years ago, at the request of the Anthropometric Society, I obtained the measurement of three hundred men of various nationalities, some born in towns, some in the country, of various occupations, of different complexions and temperaments, and of various habits. I failed to discover any satisfactory evidence to lead to the conclusion that in actual inch-measurement the town-bred man was appreciably inferior to the country-bred man. But, so far as my observation enabled me to judge, the countryman came out incontestably superior in tone of muscular activity. These figures are recorded in the Anthropometric Society's Transactions. Standing alone, they are of no value; they prove nothing, because I had no evidence at what age town-dwelling ceased. It is in the mass of statistics that we can find proof. Mr. Francis Galton, to whom science is so much indebted, has recently recorded some measurements made by himself in his laboratory at South Kensington on men during the Health Exhibition, and has made a comparison with those of Cambridge University men. Mr. Galton's inquiry extended to as many as nine thousand persons. The relation of the two points to a considerable advantage of the Cambridge men:

	Height.	Weight.	Breathing.	Pull.	Squeeze.
Cambridge	68·9 in.	153·6 lb.	254	83	87·5
Kensington	67·9 in.	143·0 lb.	219	74	85·0

These figures appear to substantiate the statistics of the Anthropometric Society: that the average well-to-do man has a higher general physical condition than the average of a lower grade of society; a similar, though not so well-defined, brain-development exists. These measurements, so far as proof of stature is concerned, must be accepted with some degree of reservation. Presuming that the Cambridge students were drafted from the upper stratum of society, and from the country mainly, there is no evidence that the other class were all from towns.

The tables of the Anthropometric Society, as issued by Mr. Roberts and published in the "York Meeting Transactions," state that the result of a comparison as to the average height and weight of the several classes of the population distinguished as (1) the professional classes, including town and country; (2) the commercial classes in towns; (3) the laboring classes in the country; and (4) the artisans in towns. The relative position of the four classes stands in the order stated, Classes 1 and 2 being taller and Classes 3 and 4 slightly shorter than the general population. This relation is maintained throughout, and the tables afford material for study as to the comparative effects of occupation and town and country life on growth. Another table (No. 6) relates to weight. Here, again, the relative position of the four classes stands in nearly the same order, Class 1 being heavier, and Class 4 (i. e., artisans in towns) lighter than the general population; but Class 3 (country laborers) very nearly coincides with the general average, and is, in general, superior in weight to Class 2 (commercial classes in towns). In other words, the occupation of the country laborer places him in weight over the town tradesman, though the latter has the advantage in height.

As regards the physical improvement or degeneracy of the population, the report of the Anthropometric Committee at the Southport meeting says: "Few statistics are in existence which help to throw light on this subject. It is generally believed that the population in the manufacturing towns of the north of England is rapidly degenerating, but a comparison of the measurements of stature and weight given in the report of the Factory Commission, and the report to the Local Government Board of the employment of children and young persons in factories, 1873, show that this is not the case."

What we want is more extensive inquiries as to measurements of persons who have lived in large towns for two or three generations, and compare them with those who have lived in the surrounding country for some generations without admixture. Such an inquiry is surrounded by difficulties, but it alone would be conclusive. My contention is, that it is in the loss of physique, of muscular tonicity, vital capacity, and vital force that the degeneracy is to be found. Let the town-dweller of the same height and weight go to the Grasmere sports or the Braemar gathering and try conclusions in wrestling or games of prowess and endurance with the hill-side man, and the issue will not long hang in doubt; the town man has no "staying power," no "muscular contractile power," and he soon comes to grief. Probably no arrest in the downward tendency of constitutional power can take place until there is some amelioration in the conditions of life to which town-dwellers are subjected. Development and integrity of cell-structure, and the processes of vital organization, are next to impossible under such circumstances of life as those to which they are exposed. This question is a broad one, and involves many ramifications. If all the circumstances connected with the so-called "sweating system" brought out by "The Lancet" Commission can be sustained as facts, a terribly hideous and degrading state of things exists among those unfortunate creatures compelled by the irony of Fate to dwell and work in the slums of our great towns. Their life is little removed from the process of wallowing in dirt, and abiding in squalor and poverty of the most appalling description. They are surrounded by every circumstance of human existence calculated to debase the mind and destroy the body. Is it possible to conceive any state of life more conducive to loss of health and dwarfing of physical development? These poor creatures appear to have no qualifying or redeeming feature in their every-day routine of life. Breathing in their insanitary homes the reeking fumes of unhealthy surroundings, an atmosphere vitiated to the last degree of respiratory fitness, to which are added unwholesome food and consequent faulty assimilation the aggregation must inevitably result in depraved constitutional integrity. Nor is there the faintest silver lining to this dark social cloud. These people have not the relieving benefit of sleeping in pure air after a day of hard work of twelve or fourteen hours' duration in the disease-laden atmosphere of insanitary workshops, but are subjected by day and by night to conditions as far removed from the sources of health as the poles are asunder. Their daily occupations and mode of life in the workshop are bad, and their homes also are bad.

It may pertinently be asked, What is the remedy to hinder further degradation of racial power, and rescue the town-dwellers from the agencies so powerfully operating upon their physical competency? I fully recognize the cogency of such a question, but I must at once admit my inability to suggest a satisfactory answer. It may to some extent be found in adopting legislative measures. No doubt sanitary reform is doing an excellent work. Insanitary surroundings, overcrowding, uncleanliness, impurity, and intemperance, must all be done away with or lessened. Educate the children in the pure air of the country, make the parents aware of the great constitutional value of sobriety and morality, give them all pure air and plenty of it, and away fly the pale faces, cachexia, lowered vitality, stunted development, muscular attenuation, and the imperfect elimination of functional products.—*The Lancet.*

SEA-LIONS AND FUR-SEALS.

By W. H. LARRABEE.

THE animals of the seal-kind include two groups or families which, with a general similarity of structure, exhibit quite distinct features in their appearance, habits, and movements. The order to which they belong is named *Pinnipedia*, from the structure of the paws, which are webbed down to the ends of the fingers, and in one of the families beyond them. The families are the *Phocidæ*, or true seals; and the *Otariidæ*, eared seals, sea-lions, or sea-bears. Two articles of the same name but very different qualities are derived from them and form important commercial wares. Seal-skin from the true seal has short, bristly hairs, and is used for trunk-covers, coats, caps, gloves, etc.; seal-skin from the eared seals is the soft, fine, glossy fur which the ladies prize so highly, and which has an important place in our luxurious winter wardrobes. These animals are carnivorous mammalia, and breathers of the air; while they hunt their food in the water, they must live out of it; hence they are found most frequently near the water, on the rocks of the coast, or floating on cakes of ice. In connection with the walrus, they have been aptly described by some writers as a kind of marine bears. Their bright, intelligent-looking faces are familiar in all our zoölogical collections, and their sports and antics are always amusing, and never fail to collect a crowd wherever they can be observed.

The true seals live in the northern seas. They are the main reliance of the Eskimo for his support, and supply him with food, light, fuel, clothes, thread, strings, and leather. The best-known species is the common seal (*Phoca vitulina*, Fig. 1), which is common in the European seas, and is often seen in New Brunswick and along the New England coast. It is brownish above and white beneath, mottled, pied, or marbled, and has a handsome hair, which is much prized by the Indians.

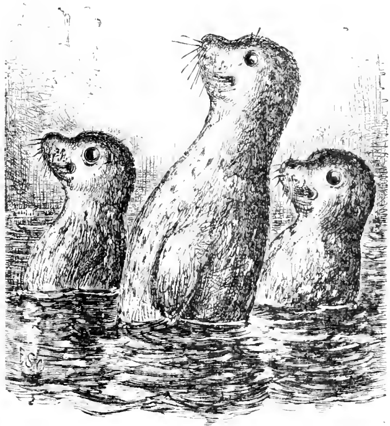

Fig. 1.—The Seal (*Phoca vitulina*).

The Greenland seal (*Phoca groenlandica*, Fig. 2), also called, from the very conspicuous manner in which the fur of the adult is colored, the harp seal, is the animal of which the Eskimos make the most use. The male is grayish-white with black markings, the female brownish with black, and the young snow-white. The animals live in herds on the floating ice along the Greenland coast, and are sometimes carried to Labrador, Newfoundland, and even to England; and they have recently been shown, by Dr. C. Hart Merriam ("Popular Science Monthly," vol. xxvii, p. 140), to be very abundant in the St. Lawrence River as far up as the Saguenay.

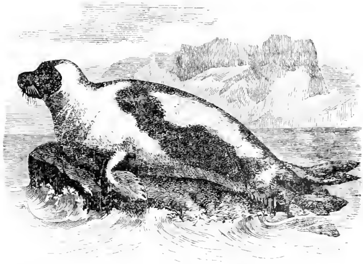

Fig. 2.—The Greenland or Harp Seal (*Phoca groenlandica*).

The hooded seal (*Stemmatopus cristatus*, Fig. 3) is distinguished from the other species by a membranous or muscular sac on the back of the head, which is penetrated by chambers communicating with the nose, and may be inflated with air when the nostrils are closed. The marks of distinction between the true seals (*Phocidæ*) and the sea-lions (*Otariidæ*) are very clear. The most obvious mark is the ears: the true seals have no external ear; the sea-lions have ears that can be seen very plainly. Hence is derived the scientific name of the family, which signifies having ears, or eared. The whole external appearance and the structure of their limbs are also different. The true seal has hardly any neck; his head and trunk, closely connected, are short, while his loins are of full length; his body is so round that his little hands can hardly touch the ground; the hands themselves are closely bound up with the body, so that hardly more than from the wrist out is free; and the hind-feet, connected with the tail, are stretched out backward. The confinement of his limbs unfits him for movement on the land, and his progress is nothing more than a series of awkward bumps and wriggles, in which the body is never raised from the ground. His situation is very different in the water, where he can use his toes like the blades of a screw-propeller, work his body to the right or left, up or down, at pleasure, rise to the surface or dive to the bottom, and, his hands furnishing him an excellent system of steerage, direct his movements with admirable precision.

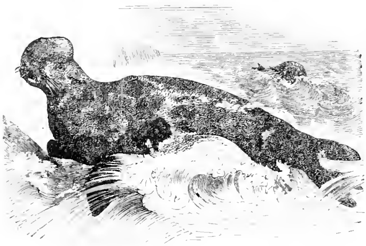

Fig. 3.—The Hooded Seal (*Stemmatopus cristatus*).

The sea-lion, having a head with pointed ears, "looking like the head of a dog with his ears cut off," large eyes, whiskers, a long neck, and a body raised upon its hind and fore limbs several inches from the ground, appears upon the land more like a land animal, while it is fully as much at home in the water as the seal. It is much more at home on the land, where its whole body is singularly lithe and flexible, and it can run nearly as fast as a man can, and get along better in a thick bush, can climb rocky ledges and steep, slippery banks. Both in water and on land it assumes a great variety of attitudes. Dr. Murie, describing its motions, says: "At one moment the entire body presents a long, cylindrical, tapering cone; in another the body seems foreshortened, and the head and neck thrust out turtle-fashion, to a length as astonishing as unexpected to any visitor who may chance to be near; at other times the chest and abdomen become deep, and laterally flattened, while the back is arched like that of a defiant cat. And so, waking and sleeping, walking or swimming, there is a ceaseless change of relation in the figure and proportion of the parts. This does not depend on mere change of attitude, but also on the unusually lithe and mobile nature of the entire spinal column and ribs, furnished as these are with an abundance of cartilaginous material and fibro-elastic ligaments."

The Otaria has generally thirty-six teeth, with canines and incisors of enormous size, so that when they close upon each other "anything that may happen to come between them is held as in a vise," and small molars, so solid that sailors have sometimes mistaken them for flints. According to Mr. J. W. Clark, of Cambridge, whose "Davis Lecture" on these animals at the London Zoölogical Gardens condenses a mass of information about them, "The Otaria, having caught its prey, holds it in its mouth by means of its powerful canines and incisors, and, raising its head, swallows it whole. When it has caught a fish too large to be thus disposed of, it has been seen to give its head a sudden twist, so as to break off a portion, which it swallows rapidly. It then dives into the water, picks up the other portion, and repeats the tearing process until the last fragment is devoured. Their food consists of fish, mollusca, crabs, and sea-fowl, especially penguins, which they catch in a most ingenious way. They lie motionless in the water, with only a small portion of their nose above the surface. This attracts the attention of the bird, which mistakes it for something eatable, and, approaching to catch it, falls a prey to the craft of its adversary." They have also the habit of swallowing pebbles, of which more than twenty pounds, some of them weighing half a pound, have been taken from one animal. The sailors say that this is for ballast, and a story is told of a female seal that was seen teaching her cub to swallow the pebbles; while another story, by an officer of the British navy, is of a sea-lion that was seen "discharging ballast."

The breeding habits of the sea-lions, as they are described by several authors, among them Mr. J. A. Allen, in the "Harvard Bulletin," and Mr. H. W. Elliott, in his report on the Pribylov group of islands, are extremely curious. They frequent solitary islands, away from inhabited coasts, in large numbers, and are supposed generally to return to the same place, or near it, year after year. Here they occupy the spaces between high-water mark and the foot of the cliffs—to which the sailors have given the name of "rookeries"—using the beach as a playground for the pups, and fixing their sleeping-places on the tops of the cliffs.

Only the old males or "married seals," and the full-grown females or "mothers," are allowed upon the rookeries. The young seals—the young males are called "bachelors"—are left to swim about in the water, or are allowed to retire behind the rookeries to the uplands back of the grounds that the old seals have appropriated to themselves. Communication between their upland haunts and the sea is given them by appointed paths, from which they are not permitted to stray to either side. The rookeries are haunted only by a few stragglers during the winter, but at the beginning of spring the older and chief males of the herd visit the place as if on a tour of inspection, swimming around cautiously, then, if all seems safe, climbing upon the rocks and examining everything carefully. The company increases very slowly till about the first of June; then, if the weather has become warm, the bull-seals come up in large numbers and select their "claims," consisting of a plot of ground about ten feet square for each animal, which he must defend against all comers. Desperate fights often take place for the possession of these little plots, at the end of which the vanquished seal withdraws humbly, while the victor quietly takes possession of his conquest. It is said, according to Mr. Clark, "that occasionally those few males who have been vanquished in all their encounters, and are therefore unable to obtain a resting-place or a wife, retire together to some distant beach, there to bury their shame, far from the society of their fellows, where they sit together gloomily, grievously wounded in body and in temper." The cow-seals arrive in about two weeks after their lords have taken possession of the grounds and selected the places for their harems, and a "universal, spasmodic, desperate fighting" takes place among the bulls. As the females come up, they are met by the "bachelors," whose duty it is to escort them to the beach and drive them up on the rocks as fast as they make their appearance. Some of them seem to be looking for some particular male, and will climb upon the rocks and call out and listen. As soon as the female has got upon the sand, the nearest male addresses her with a noise like the clucking of a hen, bows to her and coaxes her, until he gets between her and the water, when his manner changes and he begins to drive her up with angry growls. He is not yet sure of her, however, for the seals in the next line above him are on the watch to steal the most desirable prizes that their more fortunately situated fellows have captured. They take them in their mouths as cats do their kittens. Sometimes two seals contend for the same female at once, and in this case she gets terribly lacerated and sometimes torn in two. When the distribution of females has been finished, the arrangement is permanent. Each bull-seal keeps the mastery over his twelve or fifteen wives if he is in one of the front rows, five to nine if he is in a back row, and allows no intrusion on his domain. One old bull is mentioned by Mr. Elliott that had forty-five females under his charge.

The pups are born a few hours after the mothers have landed; each mother bringing forth one, seldom twins. The mothers show but little fondness for their young, but can distinguish their cries among the thousands, and each will suckle no other than her own.

The pups begin to take to the water when they are about a month old, clumsily at first, but soon becoming accustomed to the element. The rookery at the Pribylov Islands is broken up during the last days of July and the first week in August. The young have then become able to take care of themselves, and are abandoned by their mothers, who give themselves up to lounging in the waves. The "married seals," who have been constantly at their posts and restlessly active for three months without taking food or water, go down to the sea to feed and wash. Notwithstanding their long fast and hard work, they are not emaciated, but come out in good condition, having sustained life all the time by absorption of the thick stores of fat hidden under their skins. The mothers continue to idle, and the pups and "bachelors" to sport and frolic, till the storms of autumn begin to come on, when they all depart for warmer latitudes, after which they give no account of themselves till the next spring.

Dr. Gray, of the British Museum, made out nine genera and seventeen species of eared seals. He based his distinctions too often on insignificant differences, and erred to excess. Mr. Clark recognizes but nine species, and includes them all in the single genus *Otaria*. While the true seals confine themselves to cool latitudes, the Otariæ bear warmth and appear to be sensitive to changes of temperature, avoiding extreme cold. In the Atlantic Ocean they are found only in the extreme southern part, beginning at the mouth of the Rio de la Plata, and extending thence all around the coasts of South America. They are common on the coast of California, along the Aleutian Islands to the coast of Japan, and in the Pribylov Islands, in Bering Sea, their best-known resort. They are found around the coast of New Zealand, the Auckland Islands, Tasmania, and the south and east coasts of Australia, at Kerguelen's Land and the Crozets, and near the Cape of Good Hope. Most of the skins found in the market are credited to the Falkland Islands, the Cape of Good Hope, and the Pribylov Islands.

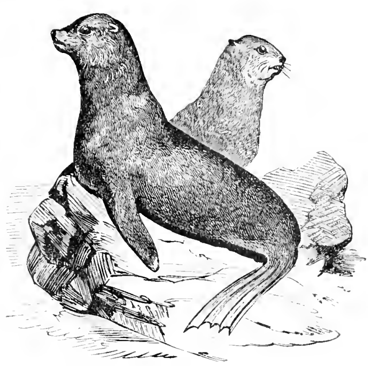

Fig. 4.—The Northern Sea-Bear (*Otaria ursina*).

The best-known species is the northern sea-bear (*Otaria ursina*, Fig. 4), which inhabits the Pribylov Islands. It frequents those islands in enormous numbers, their whole seal population being estimated at between five and six millions. The noise of this multitude is described as like the booming of a cataract, so loud as to warn vessels at sea of the proximity of land, and the smell as almost insupportable. The animal is covered with a long, flattened, moderately coarse hair, under which is a dark, long, fine, silky fur, the valuable seal-skin fur of the market.

Fig 5.—Steller's Sea-Lion (*Otaria Stelleri*).

Steller's sea-lion (*Otaria Stelleri*, Fig. 5) is a larger species, a full-grown male measuring twelve feet in length, and occasionally sixteen feet, and weighing a thousand pounds. It lives not only in remote and secluded places, like the northern species, but also by thickly inhabited coasts, where it enters the bays and rivers, and even plays around the shipping. It is much more timid than the fur-seal—which shows no fear of man—and "hurries into the water at the first alarm, and there sits, with his head and neck raised above the waves, roaring as loudly as possible, till the intruder is out of sight. Its roar is described as deep and grand, like the howling of a gale through the branches of a forest or rigging of a ship." The species is found on both coasts of the Northern Pacific Ocean, and is the animal which inhabits the "Seal Rocks" of the harbor of San Francisco, and, protected by the law, forms one of the attractions of the city. Its under-fur is so scanty, short, and fine as to be of no use for clothing; but the skin makes an excellent leather, the intestines are used to make water-proof frocks, the whiskers are sold to the Chinese for ornaments, and the flesh, the blubber, the lining of the throat, the skin of the flippers, the stomach, and some of the internal organs, are put to valuable uses.

The southern, or Cook's sea-lion (*Otaria jubata*, Fig. 6), is found around the coasts of South America from Peru to the Rio de la Plata. Its specific name is derived from its possession of a mane, or long hair covering its neck and shoulders, which is developed only in the male when he is fully adult. The fur is only sparsely developed in the young, and disappears as the animal grows older.

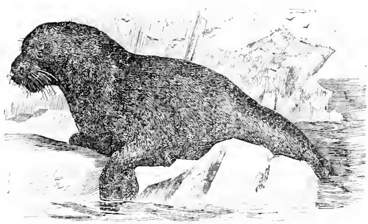

Fig. 6.—Southern Sea-Lion (*Otaria jubata*).

The Falkland fur-seal (*Otaria falklandica*), a small species of not more than four feet in length, inhabits the same localities as the *jubata*. Its habits are identical with those of the northern fur-seal, and its skins, with their thick and soft under-fur, are considered more valuable than those coming from any other region. A similar if not identical species formerly existed in the Australian and New Zealand waters, but it has been exterminated by wasteful hunting, and a correspondent wrote to Mr. Clark a few years ago, "I should as soon expect to meet a sea-lion on London Bridge as on any one of the islands in Bass's Strait." But little is known about the sea-lions of the Cape of Good Hope, which, however, furnish sixty or seventy thousand skins annually to the London market. A reckless system of hunting is tolerated, and the animals are disappearing.

The capture of the seals on the Pribylov Islands is carefully controlled by wise governmental regulations; consequently the animals thrive and are kept up in numbers, while they are fast disappearing in consequence of indiscriminate slaughter from all other quarters. The Russians established a fur company on these islands immediately after they were discovered, which slaughtered the animals recklessly for thirty years, without any regard to the danger of exterminating them. They began to diminish visibly about 1817, and in 1836 appeared in only one tenth of their former numbers. Regulations were then adopted to limit the slaughter, which have been accepted and enforced by the United States since the islands came into our possession. Only the young males or "bachelors" are allowed to be killed, during June, July, September, and October, and not more than one hundred thousand of them in each year. The "rookeries" must not be molested. The young seals are started from their haunts near the rookeries and driven over the country to the place of slaughter, which is fixed at such a distance as to obviate the danger of the older animals being alarmed by the disturbance or troubled by the odors of the slaughter. The driving is a very tedious process, and is hard upon the seals, for they become heated very easily, when the fur is spoiled, or get exhausted and die on the road. Four per cent of the flock are sometimes lost in this way. The seals are allowed to rest and cool after reaching the killing-ground, and are then dispatched in droves of about one hundred at a time. Only the fittest are slaughtered, all the others being allowed to go back to the sea. One blow on the head with a club of hard wood is generally sufficient to kill. A knife is then thrust into the vitals, and the carcass is laid aside till about a thousand have been collected, when the process of skinning begins. The skins are sent home salted, to be cured and converted into what is called "seal-skin." "It is difficult," says Mr. Clark, "to conceive how that beautiful article of dress can ever be manufactured out of the very unattractive object the skin presents at this juncture. It is hard and unyielding as a board, and the stiff, coarse hairs cover the fur so completely that its very existence might be unsuspected." The important point is to separate these hairs from the fur. They used to be pulled out one by one, till it was found that the roots of the hair were more deeply seated than those of the fur, when a cheaper and more expeditious process was adopted. The skins are now pared down on the wrong side till the roots of the hairs are cut off, when they are easily brushed away, and the fur, of varying shades of light-brown, is left in little curls. The curls become untwisted in the dyeing, and the fur assumes its well-known smooth appearance.

The seal colonies of the Pribylov Islands were leased by the Government of the United States in 1870 for twenty years to the "Alaska Commercial Company," for an annual rent of fifty thousand dollars, and a tax on each skin taken. The details of the slaughter are carefully regulated, so as to promote the well-being and perpetuation of the colony, and make it probable that, unless some unforeseen disaster befalls it, it will never be less productive than it is now.

The seals of the Greenland seas were hunted a few years ago by fleets from Peterhead, Scotland. At present, Dundee is the only port in Great Britain that sends out vessels to the seal and whale fishings. Wherever the animals frequented, they were found, like the eared seals of the Pribylov Islands, in great herds together; but would collect in the largest numbers in stormy weather, when they would seek the places free from ice, and there gambol lustily. The older seals, according to Mr. James Thornton, who derived his knowledge from frequent conversations with the ship-masters, pursue their prey with great rapidity, and when they come across a shoal of herrings, consume innumerable multitudes of them. They become very drowsy when basking in shoals on the edge of the ice with their young, and in this state are surprised by the boats' crews. Most of the victims are secured by clubbing, as at the Pribylov Islands, but the aid of the harpoon is sometimes called in when the old ones show fight. The Greenlanders, in hunting for seals, find a hole in the ice to which the animal has to come up to breathe. As soon as he puts his nose up, a harpoon is sent into it; the surrounding ice is then broken up and the victim is hauled in and dispatched with a club. The harp-seal is far more idle and wary than the common seal. "It allows itself to be approached by a small boat sufficiently near to be struck by a harpoon with a bladder attached by a long string; the moment the animal is pierced he starts off and dives, but the bladder is a tell-tale, and he is followed and repeatedly struck by an unbarbed lance until quite exhausted, when the man dispatches and takes possession of his prize."

The West Indian seal (*Monachus tropicalis*) was observed by Columbus in 1494, and has since been noticed at scattering times, but the traces of it had recently been nearly lost. Prof. Henry A. Ward, when on a visit to Yucatan and the Triangles in 1886, found several specimens of the animal, and was able to examine it in the adult and fœtal conditions. According to his account in the "American Naturalist," the head is large and prominent, and the whole body chunky, with the bones deeply imbedded in flesh and fat. The eye of the adult is very dull, having over the cornea a film which gives it "much the same appearance as a glass eye or a marble that has been so much handled as to lose its polish." The whole character of the seal is one of tropical inactivity; and this was exemplified by the presence of a growth of minute algæ on the backs and flippers of some of the animals that made them look green. They were never seen to raise their heads above the line of the back, as the harbor seal is accustomed to do. The animals showed no dread of man on the first approach, but looked lazily at the observers, perhaps uneasily shifting their position, and then dozing off into a restless sleep. But, as the

FIG. 7.—ESKIMOS SPEARING SEALS.

men drew nearer, they would rouse themselves, bark, "and uneasily hitch themselves along a few paces." At first they offered little resistance, but on the second day showed fight when attacked in groups. Except for a little savage conduct when in panic, their whole bearing was one of indecision. They showed but little of the curiosity regarding a boat and its occupants which is usually so marked among seals, and did not disport themselves in play.

The business of hunting the Greenland seals, like the whale-fishery, has been injured by the "improvements" that have been introduced into it. Screw-steamers may be more efficient in the chase than the old-fashioned sailing-vessels, but they have made the seals "wild," and have driven them further north and out of the open waters, into regions to which these vessels can hardly penetrate.

GENIUS AND TALENT.

By GRANT ALLEN.

LET it be granted that a vast deal of nonsense has been talked everywhere in this oblate spheroid of ours about almost every conceivable subject. Yet about none has a vaster amount of nonsense been talked before the tribunal of literature than about the famous old forensic case of Genius *versus* Talent. The born Genius, its sycophants and adulators continually assure us with nauseating persistence, arrives intuitively, by pure force of natural insight, at such and such a magnificent result—a "Paradise Lost," let us say, or a Blenheim Madonna, or a theory of evolution; while mere Talent, poor plodding, purblind, miserable Talent (you should always be extremely hard on Talent, with a few contemptuous crushing epithets, if you yourself wish to be thought a man of genius), toils after it in vain, with painful steps and slow, groping its uncertain way to minor truths or pettier works by the feeble rays of its own insignificant farthing rushlight. So long as Genius till lives, to be sure, and treads the solid earth, known as Genius only to an appreciative few, it does not generally receive this grateful incense of slavish adulation in its divine nostrils to any intoxicating or dangerous extent. Worship is rarely vouchsafed to contemporaries. But when once the Genius is fairly dead and buried (in Westminster Abbey or the Panthéon, as the case may be), it undergoes forthwith its due apotheosis, and a thousand lips cry out to it straightway in deafening chorus, "O Genius, how beutiful you were; how supreme; how grand; how noble; how consummate! O Genius, how masterly was your touch; how intense your feeling; how cosmical your grasp; how profound and searching and absolute your science! Alas, how infinitely did you differ in your ineffable attributes from that unequal substitute which alone we have now left among us—poor plodding, purblind, miserable Talent!" For it is commonly understood among the mesoteric worshipers of the exalted Genius that their patron is indeed a very jealous god; that he bears, like the Turk, no rival next his throne; and that he harbors in his breast a special grudge against that inferior and groveling, but somewhat similar, deity, mere commonplace Talent. He is known to regard himself, with Hebrew exclusiveness, as the original and only genuine divine entity, all others being spurious imitations.

Now, it is the misfortune of the world in this matter that the lions have chiefly painted themselves; and as the lion in the fable justly anticipated, they have invariably represented themselves as having very much the best of it. Genius, especially self-conscious Genius, has brought copious ghee to its own image; it has erected an altar to itself, like the Divus Cæsar, and has insisted strongly upon the need for public recognition of its own glorious and divine attributes. "Fall down and worship!" says Genius, in the imperative mood; and forthwith a slavish world falls down and worships. Byron, Victor Hugo, Lytton, Disraeli, have all told us, with extreme frankness, what we ought to say and think about them. We have been politely requested, in exquisite verse, to vex not the poet's mind with our shallow wit, on the concise if not very flattering ground that we can not fathom it. Genius, secure of its own Olympic supremacy, has looked down from its airy throne upon the blind and battling multitude below—meaning *us*, of course, who are not geniuses—with a sardonic smile of mingled contempt, beneficence, and pity. And the world, which is very apt to accept men in the long run at their own valuation (so much the worse for the modest), bows down in the end to self-assertive Genius, and sees in its face all those splendid qualities which Genius itself bids it look and find there. For indeed the world is by nature prone, after all, to the attitude of worship. It kneels readily. Though it chooses the objects of its adoration in strange places, yet it bends willing knees to the golden calf; and to the golden calf of success and public approbation none the less than to those other assorted golden calves which we know as wealth, rank, title, and position. It may cast mud at its deities when they are young and unrecognized, to be sure—for who can see divinity in a tweed suit?—but as soon as the voice of the people, which is the voice of God, has decreed them the laurel wreath of common praise and a guinea a line, it will immediately start a Browning Society or a Shelley Society, or, for ought I know, a Ouida Society, too, to give the new cult its appropriate hierarchy. And, above all, where the object of their worship is quite safely dead and buried (for live gods at times inconveniently disclaim their noisiest votaries), the admirers will swarm around with contagious enthusiasm in their wrath against the prophets of all newer cults, and cry aloud for the space of two hours together, "Great is Diana of the Ephesians!" till the town-clerk comes to disperse them.

On the other hand, if any bold iconoclast, sick of this perpetual adulatory hero-worship, this fulsome laudation of the divine afflatus, ventures to hint that genius, after all, does not really differ so much from mere talent—poor but honest and industrious talent—that the distinction is mainly one of degree, not of kind, and that what in its youth was simply called talent grows with time and repute into genuine genius—the orthodox worshipers have always their thunderbolt ready forged to crush and annihilate him. "This fellow," they say, with a toss of the head, "being in very truth a born frog, ventures to maintain that frogs, by dint of inflation, can puff themselves out to the dignity of oxen, or that at best there is but little difference of size and build between the two species. That is just because he is a mere frog, and jealous of the vast superiority of bovine greatness." To be sure, when the oxen themselves were yet but young bullocks, sporting in the fields, these same orthodox critics would have eagerly contended for their essential frogginess; but now that they are full grown and fat, and florally wreathed with sacrificial garlands, as becomes an Apis, the orthodox have forgotten their former recalcitrancy. As of old, the fathers stone the prophets, and the children occupy themselves with building their sepulchres. But let that pass. The point is, that if one tries to put the question as to the nature of genius in its true aspect, one is at once regarded in the invidious light of a modern Zoilus.

Nevertheless, this question of genius and talent is a truly scientific one, a psychological problem, one might almost say, in the wider sense, a matter of anthropometry. It is well that it should be discussed on scientific grounds, without any of the hysterical and inflated verbiage with which geniuses and their biographers have too frequently befogged it. Wherein does genius really consist, and how does it differ from mere talent? That, simply put, is the net question which we have here categorically to answer; and to anticipate at once the answer forced upon me as a humble observer by consideration of the facts, I find at bottom that the two are in ultimate analysis almost identical. Genius is talent either pushed to an exceptionally high degree, or exerted in a very unusual direction, or linked with a rare amount of striking industry, or dashed with a certain peculiar vein of bizarre originality. In short, it is such talent as makes itself specially remarked—talent which has in it something of the unique; while other talent, often equally great or even greater, but lacking in the special element of individuality, remains to the last "mere talent," and never attains to any higher level of public recognition.

The first form of these four is the one so aptly and bravely described by Buffon, who defined genius in his own inimitable style as "an infinite capacity for taking pains." To the general public, this admirable definition seems simply incomprehensible. "What!" they cry with one voice, "genius a capacity for taking pains! We wist it was something quite opposite—an inspiration, spontaneous and unconscious. The mere plodder, we always understood or imagined, worked away at his canvas with infinite trouble, touching and retouching till he was sick and tired of it; but the divine genius! oh no, impossible! Perish the thought! 'tis an absolute profanation. The plodder devotes himself with painstaking care to anatomy and perspective and light-and-shade and all the rest of it; but the divine genius, he, great man, comes up with a stroke of his brush intuitively, so—and behold, hi, presto! an Aphrodite or a Beatrice smiles as if by miracle before you. The plodder may potter long over his rhymes and his epithets, but the divine genius, with Byronic carelessness, dashes you off an ode or a ballad, *stans pede in uno*. His lofty Pegasus needs no goading or driving; it moves as it will of its own accord, and leads him at last without conscious guidance to some splendid, glorious, or dazzling conclusion. We know it is true, for have not our Lyttons and our Hugos told us so?"

But humble critics perceive at once that in real life things are ordered quite otherwise. Your Michael Angelos and your Leonardos think no detail of anatomy or of physics beneath their lofty notice; they study the human frame as if they meant to be doctors, the laws of matter as if they meant to be engineers, the nature of light as if they meant to be physicists, the principles of optics as if they meant to be astronomers. They toil early and late over local color and perspective and the chemistry of pigments; they perfect themselves ceaselessly upon models and drapery, upon architecture and landscape. Of course, unusual endowments of eye and hand are there to begin with; but those unusual endowments even will profit them nothing without arduous training and continuous industry. Every line of the greatest and most perfect poets bears obvious traces of utmost care and finish in workmanship; every line of the noblest and most exquisite prose bears evident marks of curious study in adjective and verb, in rhythm and cadence. The art is, to conceal one's art; the seeming felicity, the apparent ease, result, not from spontaneous inspiration, but from long and conscious practice in the adaptation of means to end, and of sound to sentiment.

Indeed, one might almost reverse the ordinary estimate and say that genius, in its most frequent form, is really talent backed up by application. To this special class of genius belong such men (to take a typical example) as Charles Darwin. It was not the mere *aperçu* of natural selection or survival of the fittest that set the seal upon Darwin's undoubted apostolate. Other men had had that same *aperçu* in greater or less degree before him: some of them smaller men, no doubt, and some of them at least his peers in grasp and ability. Wells had had it years earlier; Patrick Matthew had had it as a passing glimpse; Wallace lighted upon it almost simultaneously; Herbert Spencer trembled more than once with strange nearness upon the very verge of discovery. But what Darwin did was to raise this *aperçu* into the guiding star and mainspring of his active life; to work away at it early and late; to heap together instances *pro* and *con*; to bring out at last after endless toil that banner of a fresh epoch, the Origin of Species, with all its wonderful ancillary treatises. Darwin's mind, though broad and open, a mind of singular candor and acuteness and penetration, was not, in respect of mere general ability, very far above the average constructive mind of the better class of English scientific men. He had twenty contemporaries in the Royal Society who were probably his equals in native intellect and generalizing power. But he had no equals in industry and systematic observation; it was the combination of so much faculty for hard work with so much high organizing intelligence that enabled Darwin to produce so vast a result upon the thought of the world and the future of science, of philosophy, and of politics.

When John Gibson was studying under Canova at Rome, a young English sculptor of the divine genius order—the order represented in our own days by Mr. Richard Belt of funest memory—came to cast a lordly glance in passing around the Roman studios. Gibson himself had been born an artist—not perhaps an artist of the particular type at present exclusively admired by a cultivated clique as supreme and intense, but still in his own way a true and admirable academic artist. Apprenticed first to a wood-carver and then to a stone-cutter, the Welsh working lad determined to make himself a real sculptor. Your boy of talent placed in such circumstances would have considered himself a divinely gifted sculptor already, and would have begun turning out marble nymphs and Ganymedes and Psyches as fast as his active hands could carve them. But Gibson knew better than that. He knew he was a genius, and he determined to behave as such. He went to an anatomy class in Liverpool, where he lived, and he worked with scalpel and saw among the budding surgeons on the bones and muscles of the human frame. When he had studied drawing, modeling, and the use of the chisel, as far as England could then instruct him, he made up his mind to go to Rome; and to Rome he would go, he said, if he had to tramp it on foot. To him thus employed at molding clay in Canova's studio enter the self-taught divine genius, who has come Romeward to glance casually right and left at Michael Angelos and antique torsos, by way of a hint, but who disdains the vulgar academic aid of masters and instructors. "I thought meanly of him," says Gibson with charming frankness, "for he wouldn't watch other men at work for fear of spoiling his own originality." The divine genius went home to England, carved out his Narcissus and his Aphrodite by the light of nature, ate and drank and died at last, nameless now and utterly forgotten. Gibson stayed in Rome and studied; wasted hours on the turns and folds of a piece of drapery; threw his whole mind into the work of the day; and became at last, whatever the fashion of the moment may say, a true sculptor of immense refinement and delicacy of feeling.

This is the kind of genius that consists of high talent, backed up and re-enforced by exceptional powers of application. It is the kind we get, again, in such a thinker as John Stuart Mill, who really possessed only the average intellect of your picked university honor-man, combined with an unusual faculty for hard work, and a trained habit of keeping his mind open judicially to every breeze of varying opinion. It is the kind we get, again, in Macaulay, who added, however, to his strictly average endowments of intellect the special endowments of a marvelous memory, great command of mere language, a certain ready amount of specious brilliancy, and a singular ability for calling up and adorning concrete images. On the other hand, Macaulay's intellect, viewed as intellect pure and simple, was thoroughly commonplace, *banal*, and Philistine; he had less real thinking power, less native faculty for grasping abstract or subtle ideas, than nine out of ten ordinary educated people. It is the kind, once more, we get in most geniuses of practical life, political or social. Directed to statemanship, this high general level of ability, backed up by industry, gives us our Gladstones, our Guizots, and our Lincolns; directed to war, it gives us our Cæsars, our Napoleons, and our Wellingtons. If any man imagines that the great general wins battles by mere force of innate genius, he has only to remember the constant recurrence in the "Commentaries" of the *res frumentaria*, and the famous saying that an army "fights upon its belly." A good breakfast for his men is the chief aid to a commander's military reputation. Did not somebody once call the mighty dictator, indeed, a "monster of diligence"?

Very different is the sort of genius of which Thomas Carlyle and Charles Dickens form excellent typical examples. This is the particular species of the class on which, perhaps, the popular ideas of the characteristics of genius are mainly founded. In such cases, the genius really consists in large part of eccentricity —eccentricity pushed to an extreme in certain directions, but combined with more or less of real ability. Now, it is important to note that genius of this sort does not necessarily imply a high order of intelligence. Dickens's intelligence, for example, was by no means high; I suppose everybody would admit at once that you may search his works in vain for a single sentence worth quoting as a specimen of profundity, or insight, or wisdom. Not that I wish for a moment to run down Dickens; on the contrary, I admire him immensely; I never take up "David Copperfield" or "Nicholas Nickleby" without standing amazed and aghast afresh at the quaintness, the fertility, the oddity, the fun of his inimitable creations. No other man, we feel, could do the like; and that is just why we appreciate Dickens. Originality, in fact, is the special note of this particular type of genius; and originality is therefore often spoken of by hasty thinkers as if it were the essence of genius itself. This, however, is not strictly true, unless we mean unduly to restrict the limits of genius. There have been many great men—undoubtedly great—who were far from remarkable for their originality. The solidest intellect is often utterly wanting in brilliancy or originality. Rather is it the truth that a marked degree of original quaintness entitles even a second-rate man (and Dickens was, in the matter of pure intellect, essentially second-rate) to ungrudged admission upon the final roll-call of the immortals.

Many men have had grotesque and morbid imaginings. Dickens had them grotesque and morbid to the point of uniqueness; therefore we rightly call him a genius. His gift was not a very high or noble one; on the contrary, it was one which, in its lesser developments, belongs rather to the buffoon and the caricaturist. But in Dickens it grew so large, and so far monopolized the whole field of his invention, that it became in itself a title to immortality. Nobody else could do anything equal to it, though many people could do something in a somewhat similar but less profoundly absurd and original vein. Such men as Mill, and Bain, and Lewes, and Lyell, overtop Dickens intellectually by more than half their stature. But you might get a hundred philosophers and psychologists and men of science out of a given country before you got another "Martin Chuzzlewit." It is precisely the idiosyncrasy of the man, the mixture of faculty, that is so rare and unusual. Compound ten million human beings on the ordinary principle of mixing together ancestral strains, and among them all you will produce on an average half a dozen apiece of geologists and historians, but never again a single Dickens.

Genius of this sort, then, is not necessarily at all great; it is only unique, and in virtue of its uniqueness for the most part interesting. Not that all eccentricity and originality partake of the nature of genius either; they must have combined with them some considerable element of distinct cleverness, or they result merely in an eccentric or an original, not in a genius, properly so called. We have all known many eccentrics whose eccentricity was far indeed from being either amusing or curious; it succeeded merely in making itself supremely annoying or absurd. But the gulf that separates the mere original from the true genius is often as narrow as the gulf that intervenes between the sublime and the ridiculous. Everybody has met odd people, who lived by themselves in odd rooms, who said and did odd things, and whose veriest commonplaces had always about them some lingering flavor of misplaced wit and half-mad imagination. Such queer people, with their dash of insanity, have not infrequently a dash of genius as well, only in their case the divine spark has either never been supplied with sufficient fuel, or never blown up by the breath of appreciation into even a struggling and tentative blaze. Yet who shall say what tiny extra twist in a special direction turns any one of these undiscovered cranky souls into a Dickens, a Heine, a Rabelais, or a Cervantes? The little additional twist makes to us, the percipients, all the difference; but in the brain and mind of the man himself, how infinitesimally small must be the peculiarity of fiber or energy that ultimately determines it!

Look, again, at such a case as Carlyle's. Hundreds of caustic, saturnine Scotch laboring-folk have something the same quaint power of expression, something the same dour, grim humor, something the same vehement, self-assertive egotism. In all fundamentals, philosophical and psychological, they are absolutely identical with the grumbler of Chelsea; their hard Scotch Calvinistic creed is just his gloomy pessimism in the rough; their firm belief in a lawgiver of the cosmos, who loves neither fools nor knaves overwell, is just the crude, unelaborated form of the Carlylese political and ethical system. Add a certain native vigor and directness of language, derived by blood from that canny, clever, uneducated sage, the Ecclefechan stone-mason, the "body wha had sic names for things"; supplement it with an Edinburgh University training, backed up by a strong dose of congenial dreamy German metaphysics; turn it loose upon the world of London, or divert it by circumstances into the hard, underpaid literary channel—and a Carlyle at once emerges upon you, bursting forth in the full tide of his "picturesque bad style," in "Sartor Resartus" and the "French Revolution." Once worked, the trick can never be worked again; but, while it lasts, its effect is marvelous. The rush and go of that full tide carries us all unresistingly before it: we never pause to ask for a moment, as we whirl along helter-skelter down-stream, by what slight variations on a familiar theme the astonishing sense of hurrying, scurrying, clashing music, as of pent-up waters bursting their dams, has been laboriously designed and produced in the far recesses of that wild composer's peculiar idiosyncrasy.

If we look, however, at the families of recognized geniuses, we sometimes see, as by a flash of electric light, on what slight accidents of composition these strange results ultimately depend. "Is her sister like her?" asked an enamored poet of a friend of the family. "Very like her," the common-sense friend responded cautiously; "but I wouldn't advise you to see her just yet, or you'd find out too soon how the trick is done." For very often, the slightest exaggeration of the features in a beautiful face will make it at once either commonplace or grotesque. The family likeness in the plain sister suggests forthwith how readily with a turn more of the brush or the knife that chiseled profile might become too painfully Roman, those rich lips too obtrusively negroid, those full eyes too prominent or too lachrymose. You see with undue clearness in such cases the narrow line that separates strength from coarseness, delicacy from feebleness, the pretty from the doll-like, the stately from the hard-featured. Even so, in the families of acknowledged geniuses you see how slight indeed are the special points which distinguish the distinguished: how little the poet differs in fiber from his brother the parson; how near the dry argumentative cobbler comes to his son the materialist philosopher. Bandsman Herschel had a taste for clock-work, for mathematics, for times and seasons: his boy William, who played the oboe in the same Hanoverian regiment, and deserted in due course to be organist at Bath, carried the like tastes just a step further by making a telescope and discovering Uranus. But all his brothers and sisters were also musical, and most of them were mechanical and astronomical as well. The divine genius of William Herschel is just the general family twist, developed perhaps a trifle higher, accompanied perhaps by a somewhat profounder grasp of intellect, or merely (it may be) encouraged and made the most of by a fortunate concurrence of casual conditions. For who shall say what proportion the discovered and acknowledged geniuses of the world's scroll bear to the undiscovered and unacknowledged geniuses who swarm like tadpoles in the board-schools and workshops everywhere around us?

But what makes me above all things skeptical as to the special and exceptional inspiration of the divine genius is a consideration of the historical position of divine geniuses as we actually find them in their own environment. Posterity, divorcing the man from his age, knowing him for the most part as an isolated fact alone, sees him always larger than life, like the heroic statues it erects in his honor. It forgets too often that, in order to judge of him as a unit of humanity, we must look at him in connection with his own surroundings. We are all too apt to personify, or rather to embody and individualize, all great movements: to see in the Reformation nobody but Luther; in the

Revolution nobody but Rousseau and Robespierre and Danton; in the national struggle for American independence nobody but Washington, Jefferson, and Franklin; in the vast movements for the unity of Italy and Germany nobody but Garibaldi, Mazzini, Bismarck, and Von Moltke. But in reality, as the present age now knows well, it is largely the movement that makes the men, not the men that make the movement; and this is true of ordinary epochs as well as of great upheavals, of the thinker and the writer as well as of the soldier, the statesman, and the enthusiast. Take as a very striking example in minor matters Mark Twain. To the English reader Mark Twain is a being more or less unique, or at best he is known as the chief among two or three popular competitors in the field of so-called American humor—Artemus Ward, Josh Billings, and Orpheus C. Kerr being practically his only considerable rivals in the European market. But whoever knows the daily talk and the daily newspaper of Western America knows that embryo Mark Twains grow in Illinois on every bush, and that the raw material of the "Innocents Abroad" resounds nightly, like the voice of the Derringer, through every saloon in Iowa and Montana. A large style of cheap and effective homicidal humor, based mainly on exaggeration and grotesque incongruities, flourishes everywhere on the border-lands of American civilization. The very infants lisp in quaint Western quips, the blushing maidens whisper a dialect which "pans out" rich in the peculiar wit of Poker Flat and the Silverado Squatters. Mark Twain represents but the exceptional embodiment of this extravagant ranching and mining spirit, sedulously cultivated and still further developed by the literary habits of a professional humorist.

In literature and in political life our modern principle of the supreme influence of the environment is now, indeed, universally admitted; it is only in science and in philosophy (where more than elsewhere it is emphatically true) that anybody of authority still doubts it. We all allow that in most matters it is the wave that makes the crest, and not the crest that makes the wave. The old school of critics saw in Shakespeare a dramatic phœnix, solitary of his kind, unequaled and unapproached around or about him. The new school sees in him the final flower and highest outcome of that marvelous outburst which gave us "Faustus" and "Tamburlaine," "Jane Shore" and "Volpone," the "Duke of Milan" and the "Duchess of Malfi." *Primus inter pares* he was, no doubt, but *inter pares* only, not above "a vast dead level of mediocrity." Ford and Webster, Beaumont and Fletcher, Jonson and Massinger stood close beside the throne; Greene and Marlowe had prepared the way beforehand for Hamlet and Shylock and Richard III. The expansion of England in the Elizabethan age necessarily produced the new drama, which showed forth as in a mirror "the very age and body of the time, his form and feature," exactly as the romance of our own day shows forth the stir and ferment and turmoil of the present far greater period of national development. A great deal of what most of us take for Shakespeare is really the necessary spirit and background of the Elizabethan stage, as much the common product of the nation at large and of the dramatic tradition as the modern novel or the modern burlesque is the common product of our own civilization.

In science and philosophy, however, this general principle of necessary development is even more demonstrably true than elsewhere. There comes a crisis every now and then in the evolution of thought, when new discoveries and new inventions are, as we all say nowadays, "in the air"; when numberless workers, led up to a certain point by previous thinkers and previous discoveries, tremble all together on the very verge of the next great generalization or the next important extension of thought or knowledge. "He who says A must say B also," the wise French proverb pithily puts it. Now it sometimes happens in such cases that a number of workers co-operate so much in the new discovery, or the new invention, or the new development, that no one man carries off for himself the honors of the situation. That was the case with the vast physical concept of the conservation of energy, by far the vastest and most fundamental concept ever yet introduced into our view of the material cosmos and its mode of working. Yet that profound law was so slowly evolved by the separate labors of many acute and suggestive thinkers, beginning with Count Rumford and ending with Joule, Meyer, Helmholtz, Grove, Clerk Maxwell, Balfour Stewart, and Tait, that no single name will ever probably be associated with its promulgation, as the name of Newton is associated with the law of gravitation, or as the name of Darwin is associated with the principle of organic evolution. More frequently, however, it happens that a particular worker does either anticipate the others by a decided interval, or succeeds at any rate in attracting to himself the attention of the crowd, and in becoming, so to speak, the eponymous hero of the new conquest. In such cases I do not say that the hero is not really as a rule greater than the men he casts into the shade; but I do say that he is not as a rule as much greater as the world at large, in its love for the sweet simplicity of hero-worship, supposes him to be. It is so hard to distribute your praise equitably between a dozen or more of contributory geniuses; it is so easy to fix upon a single man and declare authoritatively in a very loud voice, "*Ipse fecit!*"

Mechanical inventions show us the working of this popular tendency in a very clear and instructive manner. Who, for example, invented the steam-engine? James Watt, says everybody, with glib readiness. But those who have looked at the history of the steam-engine know, of course, that there were steam-engines in abundance long before Watt's, and that Watt himself worked deliberately on the basis of Newcomen's model. Newcomen, in turn, had improved on Papin's invention, and Papin perhaps on De Caux's, and finally on Hero's. Now, nobody denies that Watt was a very great engineer; if he had never invented the double-acting engine at all, indeed, he would have been remembered among the mechanical geniuses of the world by his numerous other improvements and discoveries; but he was not so absolutely supreme and unique as the popular fancy has made him out to be. Indeed, taking into consideration the date of its construction, Newcomen's engine was a much more remarkable triumph of human ingenuity that James Watt's. But Watt introduced the final details which rendered steam a power in the world, and with him accordingly rest the popular suffrages as "the inventor of the steam-engine." Similarly, who invented the locomotive? George Stephenson, says everybody, as before. But those who have looked at the history of the locomotive know, of course, that both locomotives and railways existed in plenty before Stephenson's, and that the Rocket was merely the most successful competitor among many contemporary competitors for public favor. Nobody denies George Stephenson's marvelous native engineering abilities; on the whole, taking into consideration his humble beginnings, he seems to me more of a heaven-born genius in his own way than almost anybody else with whose history I am acquainted. But the work he did upon the locomotive was adaptive and developmental, not original and novel. The great invention did not spring in full panoply—like Athene from the head of Zeus—out of any one engineer's profound brain; it grew slowly, piece by piece, like everything else, from a hundred men's co-operating intelligences.

Like everything else, I say deliberately, for it is the same with every great invention. Look at the telegraph, so hotly debated between Morse and Wheatstone; look at the telephone, equally divided between Edison and Bell; look at photography, whose several stages owed so much successively to Wedgwood and Davy, to Niepce and Daguerre, to Talbot and to Archer. "Great discoveries," says Prof. Fiske, with evident wisdom, "must always be concerned with some problem of the time which many of the world's foremost minds are just then cudgeling their active brains about." It was so with the discovery of the differential calculus and of the planet Neptune; with the interpretation of the Egyptian hieroglyphics and of the cuneiform inscriptions; with the undulatory theory of light and the mechanical equivalent of heat; with the nebular hypothesis and with spectrum analysis. In some cases one man has borne off all the praise, while many men bore the brunt of the labor; in other cases the work done has been so evenly distributed among several laborers that even that unjust judge, the general public, could set none as greater or less than another, none as before or after another.

Observe, once more, a case where, at first sight, the part played by the individual genius seems exceptionally great—I mean Newton's discovery of universal gravitation. Here, surely, if ever anywhere, the genius was fully entitled to say, "Alone I did it." Yet even here it was quite as much the crisis that made Newton as Newton that made the crisis. Galileo's observations on the pendulum, Torricelli's invention of the mercurial barometer, the true theory of the common pump, Von Guericke's air-pump, Copernicus's view of the solar system, Kepler's laws of motion—all these led up, slowly but surely, by various routes, to the ultimate and inevitable discovery of the law of gravitation. The world had its problem then and there neatly presented to it. The Cartesian theory of vortices, indeed, was a premature attempt at a metaphysical, or at least an *a priori* solution of the self-same difficulty. All the early work of the seventeenth century led up directly to Newton as a foregone conclusion. Newton himself merely came, in the fullness of time, as the great, fully-equipped mathematical and physical thinker who could not fail to advance science by that one step, already foreshadowed and predestined for him by the joint work of his many predecessors.

So it was, too, with organic evolution and with evolution in general. In the last century De Maillet and Monboddo, from different sides, had caught faint glimpses (as in a glass, darkly) of the descent of animals from common progenitors. With Buffon the glimpse became a distinct idea; with Erasmus Darwin the idea grew into a fully evolved and tenable hypothesis. Lamarck gave it form and body; Goethe breathed into it a wider cosmical spirit. Even the particular notion of natural selection was hit upon simultaneously by Wallace and Darwin; while Spencer had traced out the development of mind seven years before the publication of the "Origin of Species." Kant and Laplace and Lyell led on, by many lines, to the "System of Synthetic Philosophy." Evolutionism has been a growth of numberless minds, yet in the future it will appear to the multitude at large as the work of two men, and of two men only—Charles Darwin and Herbert Spencer. I need hardly say, I hope, that no man feels more profound reverence for those two mighty thinkers than I do—indeed, I dare never trust myself to say in public how profound that reverence really is; we stand so near them still that those who estimate them at their true worth only get laughed at; but I do not think we ought ever to forget the important part played also in their great revolution by so many other able thinkers and workers, whose names will never survive into future ages.

Every now and then a great crisis occurs in the world's history when some new advance, rendered inevitable by the slow growth of the past, halts for a moment on the threshold of realization. A genius is needed to make the advance; but the genius is always then and there forthcoming from the vast reservoir of potential greatness forever present in all civilized countries. It is the noble chance that brings forth the noble knight: the men lucky enough to take the tide at its flood, lucky enough to reach maturity at the very moment of the turn, achieve a visible success perhaps somewhat disproportioned even to their real and undoubted merit. Or rather, they throw unduly into the shade the men who precede and the men who come after them. There are moments when good workers can not fail to obtain wonderful results, because those results are then and there almost forced upon them by the circumstances of science. There are moments when good men must almost of necessity become hewers of wood and drawers of water for the architectonic generation that will come after them, because the last generation has built up all the materials then available, and new stores must needs be collected before another story can possibly be added to the whole vast fabric of scientific thought. Every mighty outburst is followed close by an apparent lull, a lull during which the forces at work are expending themselves rather upon preparation than upon actual performance, upon providing fresh facts and hypotheses and suggestions rather than upon co-ordinating and interpreting the old ones.

Hence it may often happen that certain names, popularly regarded as small, may really belong to greater individualities and greater intellects than certain other names of critical and, so to speak, nodal interest. The man who comes at the exact turning-point performs in one sense a greater work than the man, however able, who chances to light upon one of the ebb-tides or intervening periods. Geology supplies us in our own day with an excellent example. Lyell's name will always be held to typify the evolutionary impulse in geology, as Darwin's does in biology, Spencer's in psychology, and Laplace's in astronomy. But of these four central names, Lyell's stands distinctly on a much lower mental level than the remaining three. On the other hand, we have now among us a geologist of the very highest ability, a man who has devoted to his chosen science a breadth and profoundness of cosmical grasp never before associated with it—I mean, of course, Archibald Geikie. It is impossible for any competent critic to look at Geikie's "Text-Book of Geology" by the side of Lyell's "Principles and Elements" without immediately recognizing the immense difference of mental stature between the two men. I do not mean merely that Geikie's work is fuller and more all-sided than Lyell's; the growth of the science and the accumulation of materials would alone suffice amply to account for that. But the lucid, orderly, and masterly arrangement, the just sense of method and proportion, the logical even development of the subject, the judicial temper, the cosmic vision, the rare combination of profound depth with perspicuous clearness, all alike place Geikie's remarkable book on a far higher level than his famous predecessor's. Yet I do not suppose Geikie's name will ever become as popularly celebrated as Lyell's. The lesser man happened upon the apter moment: he did fairly well the task he had it in hand to do; and the crisis itself more than sufficed to make him and his work conspicuous forever.

Genius, then, I humbly hold, differs from "mere talent" only in one or other out of three particulars: either it is talent of a higher order, backed up by industry; or it is the same talent, made notable by opportunity; or it is talent, often of a low grade, redeemed by exceptional originality, or combined with some piquant and arresting touch of quaintness, oddity, or it may even be grotesque deformity.

This is a democratic age—an age of socialism, of co-operation, of the revolt of the masses against the few and the privileged. We have found out in our own time that all wealth is the creation of the many: that Rome was not built in a day; that the railways, roads, canals, rivers, mines, factories, warehouses, machines, and towns of modern England, were slowly exploited by the continuous labor of thousands upon thousands of skilled workmen. We have found out that generation after generation has helped to build up our cathedrals and castles, our mills and looms, our ships and steamers, our commerce and manufactures. We know that the electric telegraph goes back at least to Gilbert's researches into magnetism in Queen Elizabeth's days; that the steam-engine goes back to the Marquis of Worcester in Charles the Second's reign; that ironclads and revolvers are not things of yesterday; that every art and every invention, though it may have its own eponym in modern times, is the joint creation of innumerable nameless and successive workers through a hundred generations. The Great Man theory has broken down, and has been replaced by a belief in Great Movements. I wish here to reclaim in the same way on behalf of the wider democracy of talent as against the exclusive oligarchy of genius. The language, the vocabulary, the idiom, the eloquence, the thought of every age is molded by a thousand unknown speakers and writers who each contributes his own part to the grand total of the literature of the day. From the lowest to the highest the gradation is regular, even, and continuous: there is no break; there is no gulf; there is no isolated peak of solitary grandeur. Here and there individuals rise a little above the mass, and form as a whole the body of thinkers. Here and there individuals rise a little above the body, and form as a whole the smaller group of men of talent. Here and there individuals rise a little above the group, often in the merest details of their personal idiosyncrasy, and attain more or less distinctly to the level which most of us recognize as genius. But from first to last the various stages of intellect or of special faculty rise gradually one above the other; the differences between the men themselves are minute; it is the differences between the effects produced upon others that elevate some on so high an imaginary pedestal above their fellows.

I know that to say all this may look invidious. I know that the polite crowd of clubs and drawing-rooms, which can not see the importance of a psychological question for its own sake, apart from personalities, will read in it throughout nothing but envy, hatred, malice, and all uncharitableness. However, on that point I am not afraid. I don't think any man living has a profounder respect than I have for the genius of Matthew Arnold, and William Morris, and Herbert Spencer, and George Meredith. I'm sure no man living has a more generous appreciation than I have for the genius of Andrew Lang and Austin Dobson, of James and Howells, of Robert Louis Stevenson and Walter Besant. I know that genius simply swarms among us; that in this age one may see such men as Croll wasting, like spendthrifts, upon a solitary problem of the glacial epoch, vast constructive and organizing powers which in any other age would have secured them world-wide fame and reputation; such men as Beddoe, working for pure love, with inexhaustible industry, through a whole lifetime, at questions which everybody else ignores and neglects; such men as Galton, filled to the brim with ingenuity, acuteness, and insight, till it oozes out at their finger-ends, pouring forth in abundance upon an unheeding world the suggestive results of their piercing, keen, and all-sided thinking. I know that genius is choking and strangling itself in the keen struggle for recognition and consequent usefulness. But I know also that if genius is a drug, talent is a weed in modern London; and that talent too deserves its due honor. Men of ability throng thick around us—men of ability so exceptionally high that in any less richly gifted age than ours it would be universally recognized and crowned as genius. The commoner such talent becomes in the world the more supereminent must be the powers, or the more peculiar the twist, or the more marked the originality which will suffice to raise it into the higher category. In other words, what is talent to-day would have been genius yesterday; what is genius to-day will be but talent as men reckon to-morrow.—*Fortnightly Review.*

INVENTIONAL GEOMETRY.

By EDWARD R. SHAW,
PRINCIPAL OF THE YONKERS HIGH-SCHOOL.

INVENTIONAL geometry is the name given to a series of carefully graded problems, thought out and arranged by that able mathematical teacher, William George Spencer, the father of the distinguished philosopher.

The little book was published in this country in 1876.* An appreciative review in the New York "Evening Post" led the writer to procure a copy, and then to set to work to solve the

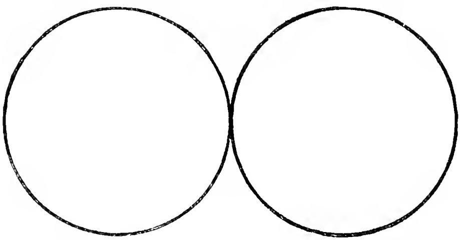

Fig. 1.

simple problems in the order given—the purpose being to form an impartial judgment of the value of the book for school use. A hundred or more problems were wrought, with increasing interest; and then, to make a further test, the book was given separately to a number of pupils, both girls and boys, each being

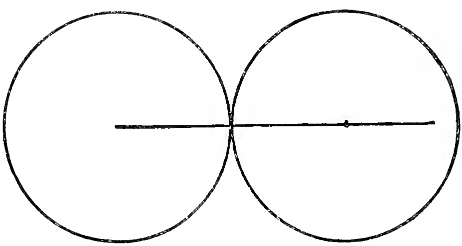

Fig. 2.

asked to work as many problems as he could. In each instance the pupil became interested in the work, and wished to continue. The remark of one girl was especially significant. "It's so different from ordinary study," she said; "there's something about it that leads me on."

A class was formed after these tests, and a few months' work

* New York, D. Appleton & Co., 1876.

proved the incalculable value of inventional geometry in a school course of study; and eleven years' experience in many classes and in different schools confirms that judgment.

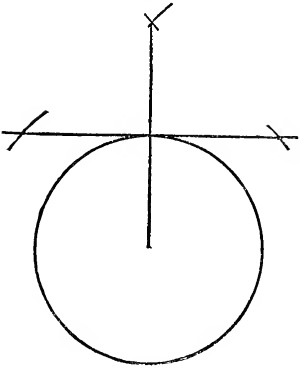

Fig. 3.

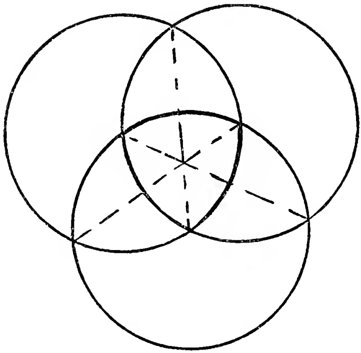

Fig. 4.

In all these classes the pleasure experienced in the study has made the work delightful both to teacher and taught; and there has always been a continuous interest from the beginning to the end of the term. This pleasure and interest came, not from any

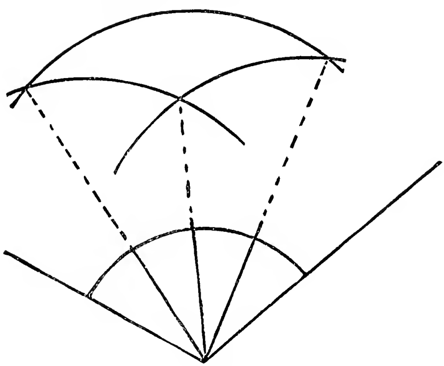

Fig. 5.

environment, not from the peculiar individuality of the class, but because the problems are so graded and stated that the pupil's progress becomes one of self-development—a realization of the highest law in education.

The accompanying illustrations of the work of one class,*

* The average age was about fourteen years. The illustrations are reproductions of drawings made by the class, though in the usual class-work the lines would be finer.

which began the study in September of the past school year and continued it till February, afford some suggestion of the scope of inventional geometry. Each pupil is equipped with a ruler, which he uses merely as a straight-edge, a pair of drawing-compasses, and a right-line pen. For a short period drawings are made with lead-pencil, till the pupil has acquired a little manual skill; then the change is made to pen, and all problems must be drawn in ink. Neatness and accuracy are insisted upon, and secured.

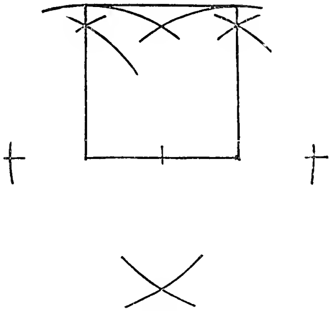

FIG. 6.

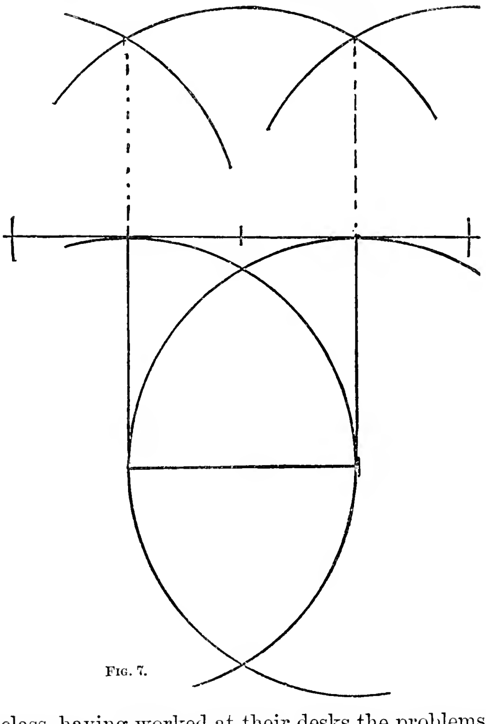

FIG. 7.

The class, having worked at their desks the problems assigned for a lesson, come up for recitation, and are directed to put their solutions upon the blackboard. The problems admit of such graphical representation on the board, and there are always so many different forms of solution, that pupils delight in this bold

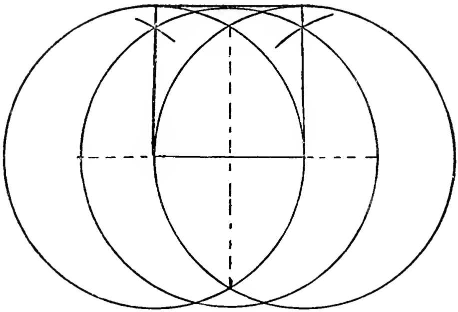

FIG. 8.

drawing of what they have wrought out at their desks. Explanation follows the drawing, in which the pupil accounts for each step and every point he has used in constructing. At the start

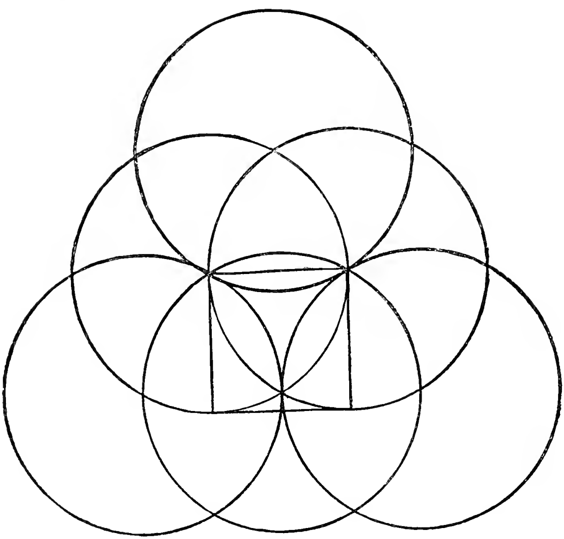

FIG. 9.

he does not see what points he may take, nor what are given. For instance, the simple problem, "Can you place two circles to touch each other at a particular point?" will likely be drawn as shown in Fig. 1. The question, "Where was the particular point?" or, the point being marked, where he must make the circles touch, brings the correct solution (Fig. 2).

Many mistakes of like nature occur in the first lessons. In every such case the pupil must be led, by questioning, to see what is incorrect. He should not be told or shown, but thrown back upon himself; for, in inventional geometry, the knowledge is to be gained by growth and experience, through the powers he possesses and the method of acquirement peculiar to his mind. Occasionally the pupil is not a little baffled, and the skill of the

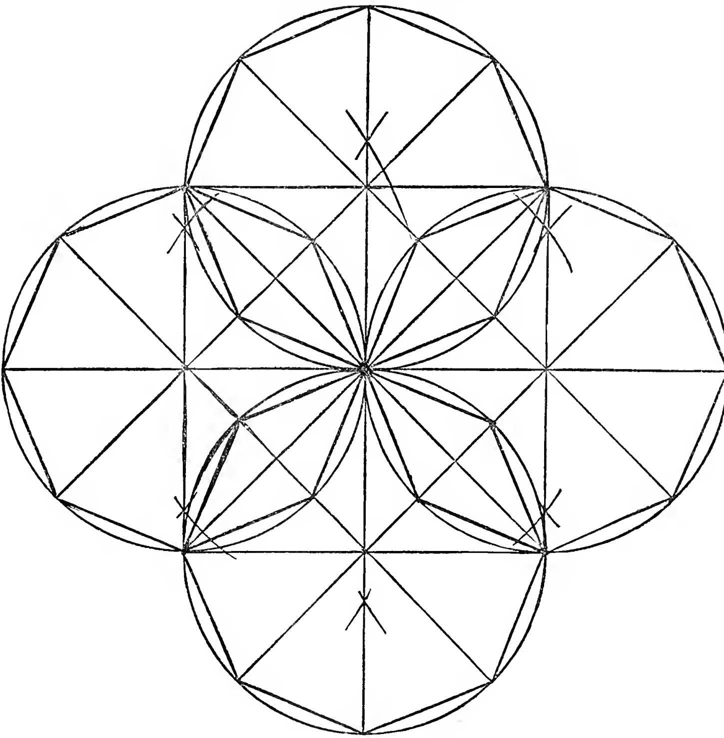

FIG. 10.

teacher is put to its best test to gain the solution without showing or telling him. Telling or showing is the method of the instructor—not of the teacher. The following problem (Fig. 3), "Given a circle, and a tangent to that circle, it is required to find the point in the circumference to which it is a tangent," is one of these difficult ones. Not many of these occur; the author, however, has a purpose in these few. For the most part the pupil is able by the grading to go on without questioning, as will readily be seen by examining the problem of which Fig. 4 is the solution, and the questions based upon it:

"Place three circles so that the circumference of each may rest upon the centers of the other two, and find the center of the curvilinear figure which is common to all the three circles."

"That point in an equilateral triangle which is equally distant from each side of the triangle, and equally distant from each of the angular points of the triangle, is called the center of the triangle."

"Can you make an equilateral triangle whose sides shall be two inches, and find the center of it?"

"Can you place a circle in an equilateral triangle?"

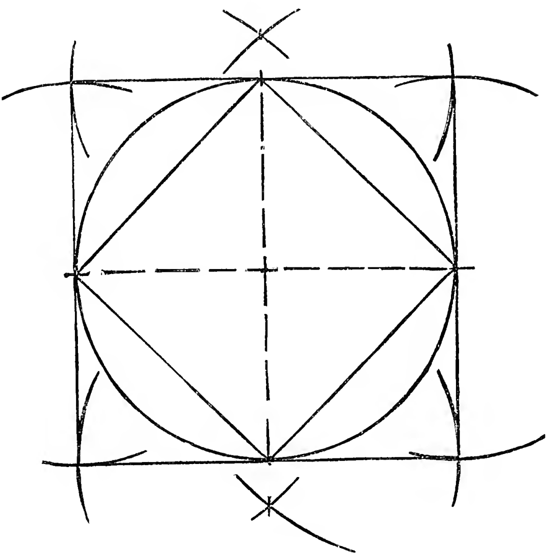

FIG. 11.

"Can you divide an equilateral triangle into six parts that shall be equal and similar?"

"Can you divide an equilateral triangle into three equal and similar parts?"

To exercise to the utmost the pupil's power to invent, problems are given with certain restrictions: "Can you divide an angle into four equal angles without using more than four circles?" (Fig. 5).

"Can you construct a square on a line without using any other radius than the length of the line?" (Figs. 6, 7, 8, and 9).

Such problems as that solved in Fig. 10, "Can you place four octagons to meet in one point and to overlap each other to an equal extent?" delight the eye by beauty of form, and teach the pupil the basis of geometrical design.

Figs. 11 and 12, solutions to "Can you fit a square inside a circle, and another outside, in such positions with regard to each other as shall show the ratio the inner one has to the outer?"

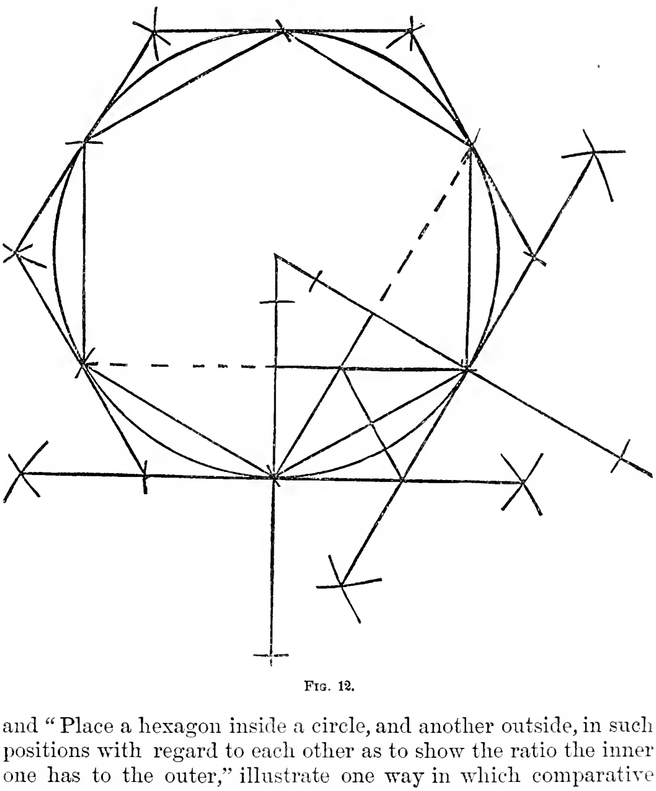

FIG. 12.

and "Place a hexagon inside a circle, and another outside, in such positions with regard to each other as to show the ratio the inner one has to the outer," illustrate one way in which comparative area of figures is treated.

We have spoken of the pleasure a class experiences in putting their solutions upon the blackboard, and in examining the drawings of each other and following the explanations. There continually come up at these times incidents of this sort: Fig. 13 is given as a solution of "Can you raise a perpendicular to a line, and from the end of it?"

In his explanation the pupil points out the given line, the end from which he is to erect the perpendicular, the point from which as a center he sweeps each circle, why he may take that point, and

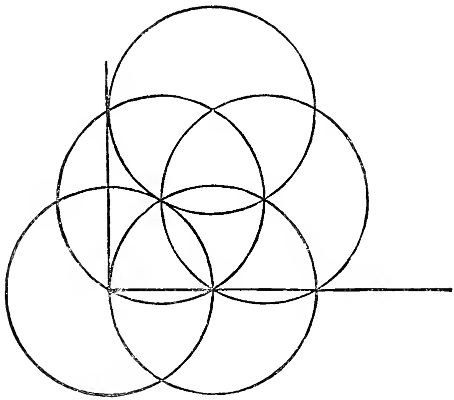

Fig. 13.

why he sweeps the circle. Another pupil discovers, before the explanation is finished, that the problem can be solved with one less circle, and there is the keenest interest while he draws and explains his way (Fig. 14).

The original and independent power acquired is shown in Figs.

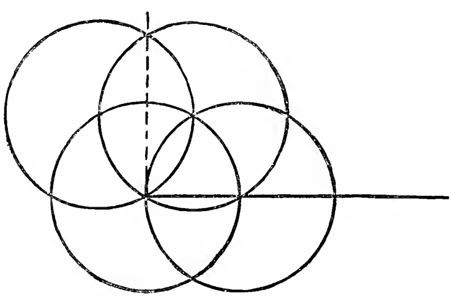

Fig. 14.

15, 16, 17, and 18, solutions of the problem, "Can you make an octagon with one side given?"

Spencer's "Inventional Geometry" is one of the most original

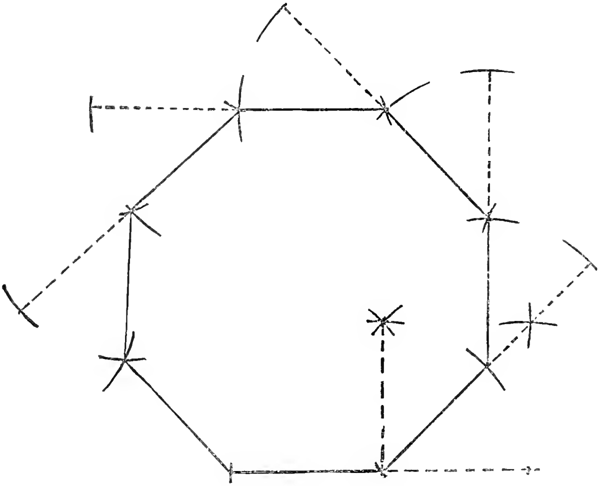

FIG. 15.

and scientific contributions to school text-book literature ever made. What this little book teaches simply and naturally was

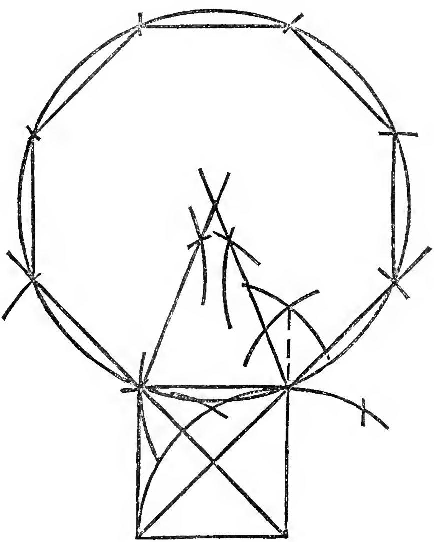

FIG. 16.

taught by going over demonstrative geometry, then taking up mechanical drawing, and adding to these personal experience. The author has secured all this and much more. He appeals first to the inventive faculty, seeks expression through the hand, and brings before the eye accurate and beautiful forms of the pupil's own constructing. The eye is trained to accuracy and similarity of forms, invention is quickened, comparison and judgment are constantly exercised, and inductive growth of mind is directly promoted. Besides the manual skill gained in constructing figures, and the power acquired to deal with original ques-

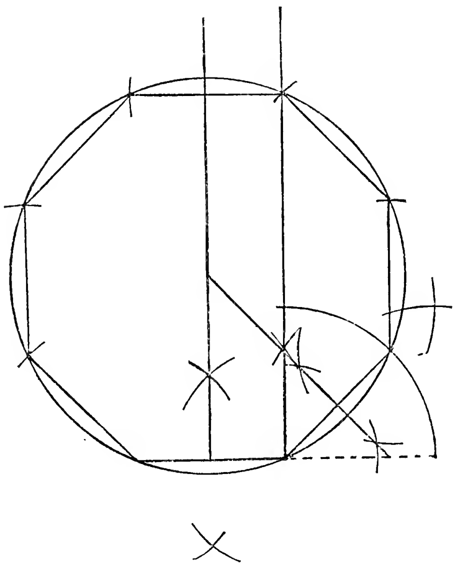

Fig. 17.

tions through the constant appeal to invention, the pupil gains by his own efforts proofs of theorems really conclusive in themselves, though not the syllogistic form of proof belonging to the deductive science.

In but one of a great number of schools visited has the writer found inventional geometry used, and in that school quite out of the design of the author. It should precede demonstrative geometry, so as to give the pupil many concepts to draw upon when he takes up syllogistic demonstration. Demonstrative geometry then becomes an easier subject, and he is surer of what he is doing, because he has more general notions as a basis. In the school alluded to, the pupils were constructing figures and then demonstrating the questions, making the study simply supplementary to ordinary geometry. There was little invention. Nearly all the constructions were noticeable adaptations of what had been drawn for demonstration in the deductive study.

Nor have the advocates of industrial training, with but one exception, so far as the writer has been able to learn, availed themselves of this study, which is not tentative, but directly in the line of what they urge.

Inventional geometry should be given a place in every school; and, if it becomes a question of time between that and demonstrative geometry, assign the time, in nearly every instance, to the former, because it is of far greater practical value, and many times more educative.

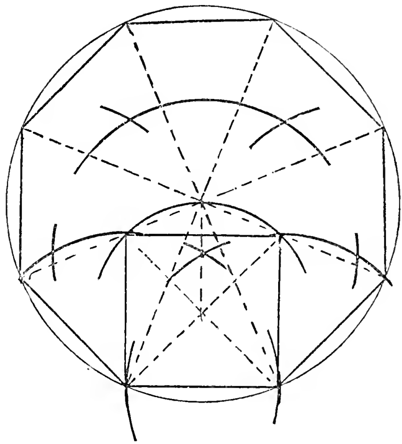

FIG. 18.

SCIENCE AND ITS ACCUSERS.

BY W. D. LE SUEUR.

NOT many months ago we had in a single number of a leading English review—the "Contemporary"—no less than two articles by able writers lamenting the disintegrating action of science on morality and religion. The first of these was from the pen of the eminent Belgian publicist, M. Émile de Laveleye, and was entitled "The Future of Religion"; the second, contributed by Miss Frances Power Cobbe, dealt in a trenchant and aggressive manner with "The Scientific Spirit of the Age." Both writers seem to be strong anti-Darwinians; but both attack the Darwinian doctrine, not on scientific grounds, but on account of its alleged incompatibility with views and sentiments which they regard as of pre-eminent importance. The only relevant criticism, however, that can be directed against a scientific doctrine is one intended to show that it is not what it claims to be—

that it is not scientific—that it has no proper place in the scheme of our acquired and organized knowledge. If a scientific opinion is not established, if it is not demonstrated beyond all possibility of cavil, why concern one's self about it, except to invalidate the claims that may have been wrongly put forward on its behalf? To discuss its bearing on religion is merely to suggest that it is true, but that "pity 'tis 'tis true," and to offer a premium to weak souls to try to persuade themselves that it is not true. If a doctrine is true, and yet inconsistent with a certain theological scheme, what is going to be done about it? Will whole books of lamentations nullify it? Will it be disproved by the most diffuse argumentation designed to show that, if it holds its ground, something else will have to give way? Of course it will hold its ground if it is true; and of course whatever is inconsistent with it must give way, and the world must adapt itself as best it can to the change.

But let us consider in detail some of the accusations brought against modern science and its professors by the critics whose names we have mentioned. "Darwinism," says M. de Laveleye, "applied to social sciences, sets aside all notions of equality, and simply glorifies the triumph of the strongest and the cleverest." Darwinism is properly a form or phase of biological doctrine, and as such does not glorify anything particularly. Even in the realm to which it strictly applies there is no glorification of natural selection, merely a recognition of the fact that natural selection is an active agency in the production of results that come under our observation. The only possible application of Darwinism to "social sciences" would lie in a close examination of social phenomena, in order to see whether there also a principle of natural selection might be found to be at work. In this sense Darwinism may be said to have been applied to the social sciences, and with good results so far as our comprehension of social phenomena is concerned. But is it a sin to understand social phenomena? In all other departments of observation we esteem it a great advantage to get on the track of Nature's operations, to be able to follow her secret processes; and it is really difficult to see why we should debar ourselves from understanding, as far as it may be given to us to do so, the course of things in the social order. The true Darwinian does not seek to impose a law on things—he leaves that to his theological censors; he is content to discover law *in* things. There is simply no sense, therefore, in talking of the Darwinian exulting in force, or glorifying "the triumph of the strongest and the cleverest." At the same time it may be remarked that it is hard to understand how, except by some very special and extraordinary interposition of Providence, "the strongest and the cleverest" are to be prevented from triumphing; and upon the whole it seems a more natural, and indeed beneficial arrangement, that the "strong and clever" should dominate the weak and stupid, than that the weak and stupid should dominate the strong and clever. We doubt whether Nature will wait for the approval of the Darwinian or of any one else before giving, as a general thing, the race to the swift, the battle to the strong, and wages to the man who can earn them.

The Darwinian is accused by the Belgian philosopher of holding that "charity and pretended justice interfere very wrongly" when they seek to prevent stronger races and individuals from usurping the place of weaker ones. The Darwinian takes up no such absurd position. He is an observer of nature, we can not too often repeat, and not a lawgiver. As an observer of nature he perceives that physical strength divorced from intellectual strength is ineffectual, and, in the struggle for life, hardly to be distinguished from weakness. He observes further that intellectual acuteness divorced from moral sentiment overreaches itself, and becomes a kind of stupidity. From multiplied observations of this nature he forms a truer idea, probably, than any mere *a priori* reasoner as to the forces which rule the world now, and as to those which will be chiefly dominant in the future. He is not opposed to any charity that, in his judgment, tends to make men better; but he could not be a man of any sense if he were not opposed to much that calls itself charity. As to justice, he sees in it the expression of a social force, which has its origin in the fact that society is an organism, the general life of which reacts upon any abnormal manifestations in special members or organs. Far from its being true that justice "stands in the way of the application of natural laws," justice may be said to be a striking illustration of the great natural law or axiom that the whole is greater than the part. To abandon justice would be to place all social order at the mercy of individual caprice; in other words, it would be the suicide of society.

We are next treated to an imaginative sketch of what the world would be like in the absence of all religion: "There is no God and no immutable type of truth and justice." Just how the persuasion that there is no God is going to take possession of mankind is not explained, whether through the utter breaking down of the evidence upon which the doctrine of a Divine Being has heretofore been believed in, or through some further progress of philosophical speculation. One is tempted to ask, however, what the critic really wants. Are there certain doctrines which he wishes to shield from criticism? If so, why not say so distinctly? Why not say in plain terms that mankind has, in some way difficult to explain, got possession of certain opinions or convictions of inestimable value, but which can no more bear examination than a soap-bubble can bear handling, and that therefore these must, at all costs, be protected from every breath of criticism? If this is not what is meant, if, on the contrary, it is maintained that the being of God is a luminous truth, proclaiming itself in the very heart of man, why not challenge all the philosophies of the world to assail it at their peril? Why not say to Darwinians and all others: "Push your researches as far as you like; make your most comprehensive inductions, your widest generalizations; construct your most daring theories: not only will nothing impair this great central truth of Deity, but all the truths you gather will lack significance till illuminated by it"? But, strictly speaking, the Darwinian theory has nothing to do with the question as to the existence of God. It is no more atheistic in its nature than the Newtonian theory of gravitation. The latter substituted for the *angeli rectores* of Kepler an all-pervading law of matter; and Darwinism substitutes for certain supposed acts of spasmodic creation an orderly sequence of development; but neither one nor the other professes to say how the origin of the universe should be conceived. If Darwinism has weakened the argument for theism in certain minds, it has strengthened it in others—witness the recent address of Mr. Balfour on "Positivism," before the Church Congress at Manchester.

We are threatened with the destruction of an "immutable type of truth and justice"; but what is the exact meaning of these words? If truth is the conformity of statement to fact, how can the idea of truth ever vanish from the world? Certainly, if such a result should ever come about, it would not be due to the influence of any honest form of scientific thought. We do not think any one will say that Mr. Darwin did anything in his long lifetime to weaken respect for truth, or to make truth less a reality in the world. We know some people whose efforts do tend strongly in that direction; but, for the most part, they are not Darwinians; they are people who can not bring themselves to define the terms they use, and who try to make authority do the work of demonstration. So successful, unfortunately, are teachers of this class, that throughout a large portion of society—the portion in which Darwinism is very generally flouted and scouted—a sense for truth in intellectual matters is most conspicuously lacking. As to an "immutable type of justice," does any one know what that means? Can any one conceive what an immutable type of justice would be like? How would it be expressed? In an act? We can either now conceive an act that would serve as an immutable type of justice, or we can not: if we can, then the type is safe; if we can not—which we imagine is the truth—then we must forego the hope of an immutable type, and content ourselves with what perhaps is good enough for us—relative justice—such justice as will serve our need from day to day.

Another threat held out is the miserable condition to which human life would be reduced if faith in a future life should disappear—a result that Darwinism is credited with hastening. Let us talk seriously on this subject. If there is evidence of a conscious life for human beings beyond the grave, Darwinism surely can not overthrow it. It may possibly be that heretofore the doctrine of immortality has been taught on very insufficient grounds, and that Darwinism has so far awakened the popular intelligence that the insufficiency has become apparent; but, if so, Darwinism is not to blame. It is simply a question of repairing the breaches in a damaged argument. A true doctrine does not need false supports; on the contrary, no greater service can be rendered to a true doctrine than to throw it back on its legitimate proofs. So far, therefore, as this or any other doctrine is true, Darwinism can only establish it the more firmly by taking away the insecure foundations on which it may provisionally have rested. The question is worth raising, however, whether the invalidation of this theory of a future life—not that we see how Darwinism as such is going to accomplish such a result—would have so disastrous an effect as M. de Laveleye assumes upon human happiness. He imagines some one addressing the toilers of the world, and bidding them, as "there is no compensation elsewhere," to raise their heads, "too long bent to the dust beneath the yoke of tyrants and priests." Is it possible that so distinguished a liberal as M. de Laveleye wants to join himself to tyrants and priests in their endeavors to hold down the working-classes by the promise or the lure of "compensation elsewhere"? Compensation for what? For injustice? But if the next world is to make amends for the injustices of this, then why lament over what the people might do if they rose against the holders of wealth? At the worst they could only work injustice, and the next world will make amends for all that. Why should not next-world sauce, that is found so admirably adapted for the laboring-man goose, be equally suitable for the capitalist gander? But if it is not injustice, but merely misery, for which a compensation is to be found in a future life, the lesson to be learned, we presume, is that the miseries of this life are to be endured in a patient spirit, and that no particular effort need be made to redress them here and now. But how all this talk about a future life tends to confuse our ideas and paralyze our activities in dealing with present interests! Instead of trying to administer an anodyne to those who suffer by holding out promises of future enjoyment, we should be far more disposed to tell them that their right and duty is to make the best of this world; and that the best will be made of it by studying and conforming to the conditions on which happiness depends—the conditions that make for the general improvement of life, physical and social. To speak plainly, it seems to us a very mean business for those who occupy positions of vantage in this world to preach compensation in another world to their less favorably situated brethren, in order to make them contented with their lot here. The sooner the calculations of all men are placed on a present-world basis, the better it will be for every important human interest.

But we are told that, not infrequently, "with religion morality also disappears"; inasmuch as "science, when reduced to material observation, can only know what is, not what ought to be." What is meant by reducing science to "material observation"? Science, we take it, observes all that can be observed; and we are not aware of any proposition to cut science off from any field in which observation is possible. If science—in the broadest sense—can not teach us what ought to be, what can? The fact is, that "what ought to be" depends in the most intimate manner on what is; so that, the more perfectly one knows what is, the more clearly he discerns what ought to be. Let any intelligent man examine himself, and say whether any sense of obligation he has does not directly result from some knowledge he possesses of what is. "The denial of the spirituality of the soul," says our philosopher, "uproots all reasonable motives for being just and honest." But supposing that one religiously refrains from either affirming or denying a proposition the terms of which he can not understand, is there any obstacle to his being just and honest? We trow not; and this attitude of mind, we fancy, is that which characterizes most thinkers of the Darwinian or evolutionist school. But why any speculative opinion on the nature of "the soul" should stand in the way of anybody's honesty, it is hard to understand. If the opinion, whatever it may be, has been honestly arrived at, and is honestly held, that simple fact will be a guarantee to some extent for honesty in other matters. It is not difficult to find people whose views about "the soul" are quite unexceptionable from the orthodox point of view, but whose daily practice is far from exemplifying a high type of honesty and justice. "Duty without God or a future life," we are sententiously informed, "is a very fine word, but it has no meaning whatever." Alas! what meaning has it with many of those who profess the strongest belief in these doctrines? We should like to ask M. de Laveleye and others who talk in this fashion whether, on the strength of their own experience, they can affirm that theological unbelievers as a class are morally inferior to believers. The fact is, as we believe, that the average of morality in the so-called orthodox world is very poor, and that it will continue to be so until a new element is introduced into it from the scientific study of nature, the element of intellectual honesty. It is easy to make such statements as that, "if all religious feeling were to melt away, a return to primitive barbarism would be inevitable," but to prove them might not be so easy. It may be remarked that primitive barbarism has always been marked by strong religious feeling as well as by comprehensive ignorance; and, therefore, if we succeeded in getting back to primitive barbarism, we should have reached a fine starting-point for another religious evolution. M. de Laveleye, however, does not expect that things will get to this pass; his idea is that our future civilization will be presided over by a purified form of Christianity based upon the most elevated teachings of its Founder. What the future of Darwinism will be he does not tell us—whether it will vanish from the earth like an exhalation, or mingle with and perchance support the new creed. If the former is to be its destiny, we should have some hint as to the probable manner of its going; if the latter, it is hard to see why it should have been made an object of attack.

Miss Cobbe, who discusses "The Scientific Spirit of the Age," admits that she does it "from an adverse point of view." The "epoch-making biography of Mr. Darwin," containing his "admirably candid avowal of the gradual extinction in his mind of the æsthetic and religious elements," has, she thinks, "arrested not a few science-worshipers with the query, What shall it profit a man if he find the origin of species and know exactly how earthworms and sun-dews conduct themselves, if all the while he grow blind to the loveliness of nature, deaf to music, insensible to poetry, and as unable to lift his soul to the divine and eternal as were the primeval apes from whom he has descended?" Miss Cobbe hastens to show that, for her own part, she has not sacrificed everything to science, by making a few remarks in a very unscientific spirit on the effects of scientific study. It promotes, she tells us, practical materialism. The student of science will—we quote the actual words of this once highly rational and thoroughly liberal-minded writer—"view his mother's tears not as expressions of her sorrow, but as solutions of muriates and carbonates of soda, and of phosphates of lime; and he will reflect that they were caused, not by his heartlessness, but by cerebral pressure on her lachrymal glands. When she dies, he will 'peep and botanize' on her grave, not with the poet's sense of the sacrilegiousness of such ill-placed curiosity, but with the serene conviction of the meritoriousness of accurate observation of the flora of a cemetery." What are we to say of this if not that it is unmitigated trash? Is it known that home affections are less powerful or less sacred in scientific than in unscientific households? Is there even ground to conjecture that such is the case? If not, such language as the above simply shows that Miss Cobbe, who has written so much and so well in times past, is growing hysterical at the very period of life when we might have expected to see her manifesting in a special degree the qualities of moderation and self-control, of calm insight and wide sympathy.

Miss Cobbe objects to the scientific spirit that it makes much of disease and little of sin. If so, it is simply inverting the habit of past times, which was to make much of sin and little of disease. And what was "sin" in the apprehension of our ecclesiastically-directed forefathers? To a large extent it consisted in what the clergy of a certain church would call "irregularity"—some want of conformity with ecclesiastical rules and requirements. It was by no means always coincident with immorality. A man might have a lively sense of "sin" in connection with some purely ceremonial matter, and very little sense of wrong-doing in connection with the most grievous offenses against his fellow-man. In obedience to the "code of honor," men who regarded themselves as pillars of church and state would prepare to commit deliberate murder; while they would always consider a gambling debt as vastly more sacred than one incurred for food or clothing. The "Christian" nations have found enormous quantities of "sin" in heresy, and very little indeed in mutual bloodshed on the most appalling scale. Pious monarchs have appeased their consciences by persecuting the Jews, and pious folk generally by hunting witches. According to popular opinion in our own day, the Divine anger is much more quickly kindled by the parody of a religious rite than by the most hideous villainy perpetrated by a man upon his neighbor. Every now and again there is a story in the papers about some boy or man struck blind or dumb for blasphemy, or of the personal appearance of the devil among some group of revelers engaged in profanely mocking a religious ceremony! So various have been the aspects in which "sin" has presented itself, and so little relation has it seemed to bear in any of its best recognized forms with practical morality, that it is not to be wondered at if scientific men show some impatience with so vague and unsatisfactory a conception, and prefer to consider all conduct simply in its bearing on intelligible human interests. As to disease, they necessarily regard it as the great enemy, primarily, of man's physical estate, and secondarily of his intellectual and moral constitution; and if their chief efforts are bent on its extermination, it would be hard to say in what more useful work they could be engaged.

The next fault that Miss Cobbe finds with the scientific spirit, which she characterizes as "analytic, self-asserting, critical," is that it is directly opposed to the "synthetic, reverential, sympathizing spirit of art"; and she holds up to scorn the physicist who can not enjoy the representation of figures suspended in the air in defiance of the law of gravity, and the zoölogist who fails to admire cherubs without stomachs, and centaurs with a stomach to spare. Well, if we must confess it, our sympathy in each case is with the man of science; and we refuse to believe, on any evidence as yet tendered, that art would be less art if it condescended to recognize the laws of the physical universe. The poet Horace was no mean artist in his day, nor is there any reason to suppose that he was a victim to the scientific spirit; yet he has left on record his distaste for all such composite and unnatural creations as Miss Cobbe takes under her protection. He thought the centaur and the mermaid both very ridiculous figures. "Let a thing be what it may," he said, "but let it be simple, let it preserve its unity." * The greatest sculptors the world ever saw, those of ancient Greece, devoted themselves almost wholly to the delineation of the human form in its ideal perfection; their art may have sought to transcend the actual, but not the possible. If they strove to better nature, it was not by flying in the face of natural laws, but by a happier blending of natural elements; just as the gardener of to-day shows us what may be realized by giving to various plants better conditions than can be commanded in the rude competition for existence. Miss Cobbe will have it that the scientific spirit would kill poetry. We do not believe a word of it; but we do believe that the scientific spirit applied to poetry would purge it of many morbid growths and ridiculous conceits. Some not incompetent judges are of the opinion that the very poem cited by Miss Cobbe in illustration, Shelley's "Sensitive-Plant," is overladen with imagery. The late Mr. Arnold did not find Shelley quite "sane" enough to be a poet of the first order; and if representatives of the scientific spirit occasionally find something in his verse that they can not quite reconcile with common sense, they may plead that they are only finding what a great literary critic had already found. In lieu of such delicate fancies as Shelley has woven into his "Sensitive-Plant," the scientific spirit, we are told, would "describe how the garden had been thoroughly drained and scientifically manured with guano and sewage." This is not argument; it is hysteria running a little toward coarseness.

But may it be claimed that science is advancing the interests of truth? No; not the science of our time. We are simply gathering facts and deducing laws, subject to rectification when further facts shall have been gathered. But "in other days truth was deemed something nobler than this. It was the interests

* "Denique sit quidvis, simplex duntaxat et unum."—*Ars Poetica*, 23.

that lay behind and beyond the facts, their possible bearings on man's deepest yearnings and sublimest hopes, which gave dignity and meaning to the humblest researches into rocks and plants." A little definition would come in well here. What *are* the interests that lie beyond the facts? What *are* man's deepest yearnings? What *are* his sublimest hopes? Are his sublimest hopes also his best-founded and most rational hopes? Are his deepest yearnings at all of a practical character? If these yearnings can be appeased at all by scientific conclusions, why not by those arrived at in our day as well as by the less correct ones arrived at in former days? Finally, what can science do more than put the most rational construction on facts? If more than this is wanted—some surplusage of belief—it can be got from other quarters; science should not be held responsible for furnishing it, or blamable for not furnishing it. Miss Cobbe does not seem to be of this opinion, however. She says that, as "Science has repeatedly renounced all pretension to throw light in any direction beyond the sequence of physical causes and effects, she has . . . abandoned her claim to be man's guide to truth." But surely, if at any time in the past Science made good her claim to transcend the sequence of physical causes and effects, we need not concern ourselves with her present denegation of authority in the higher region. If a teacher has really succeeded in teaching us the calculus, we need not trouble ourselves much if he should at some future time take it into his head that he never knew it himself. Supposing even that he never did know it, and that we only worked into it by the aid of his blunders, does not our knowledge remain? And what, in that case, can we do better than turn round and teach our teacher? On the other hand, if our teacher never knew what he thought he knew, and if we never learned what we thought we had learned, what can we both do better than acknowledge the true state of the case, and begin over again, should it seem desirable?

We are told that Darwin "has destroyed, for those who accept his views, the possibility for a rational reverence for the dictates of conscience." How? By raising a doubt as to "whether the convictions of man's mind, which has been developed from the mind of the lower animals, *are of any value*." We should suppose that, the further back an organism could be traced, the more authority might be attached to what seem to be its laws. Who would not much rather trust a conscience that had a long history behind it, one stretching back even into the brute creation, than a brand-new article of whose genesis no satisfactory account could be given? Moreover, how is it that we think so little of another man's conscience when it enjoins acts of which we disapprove; and that he thinks so little of ours when it enjoins acts of which he disapproves? It no more occurs to us to think that the Deity has specially enlightened him on the point in question, than it occurs to him to pay our conscientious conviction a similar compliment. We get over the difficulty, not improbably, by hinting that he is a "crank," and the same mode of escape is open to him in relation to us. The criticism of conscience, as Miss Cobbe must well know, antedates Darwin by at least three centuries. The philosopher whose motto was "*Que sais-je?*" expounded its weaknesses more fully than Darwin ever did; and Locke defines it very briefly as "our own opinion of the moral rectitude or pravity of our own actions." Dugald Stewart shows that the sentiment of the sacredness of property varies from country to country, according to the amount of labor requisite to produce articles of value; and that in other respects local accidents decide to a great extent the form that moral opinion takes. Hartley explained the phenomena of conscience by association; and, since his day, to go no further back, the idea of conscience as a special organ uttering the voice of the Deity has been weakening among thinking men. The evolutionists of to-day have simply succeeded in giving a wider basis to views that were in the world long before their time; but to say that they have in any way lowered the dignity of man's moral nature is to state what is not the case. Miss Cobbe is pleased to suggest that the old ideas gave a basis for moral effort "as firm as the law of the universe itself"; but that henceforth our only fulcrum will be "the sand-heap of hereditary experiences." If anything could less deserve the designation of "sand-heap" than our accumulated hereditary experiences, we should like to know what it is. In the case of the sand-heap there is an utter lack of cohesion; in the case of hereditary experiences cohesion is of their very nature. Miss Cobbe understands this perfectly; it is a pity she should have written as though she did not.

We are very far, therefore, from admitting that "the scientific spirit" has "sprung a mine under the deepest foundations of morality"; or that it is as impossible for a man who holds the evolutionary idea of the origin of conscience "to cherish a great moral ambition as it is for a stream to rise above its source." If, on the one hand, science moderates ambition by keeping before the mind the limits of the possible, on the other it stimulates ambition by producing the conviction that certain things are not only possible, but certain of attainment if the right means are used. There was a time in the history of science when men were laboring to transmute the baser metals into gold; that particular ambition has been abandoned with others equally chimerical; but it surely can not be said that science to-day discourages effort in the field of chemistry? Precisely so in the moral region: we no longer expect to work miracles, but we do expect and hope by wisely concerted measures to accomplish better and greater results than were ever accomplished by the enthusiasms and fanaticisms of the past. Miss Cobbe says that "the man of science may be anxious to abolish vice and crime, . . . but he has no longing to enthrone in their place a lofty virtue demanding his heart and life's devotion. He is almost as much disturbed by extreme goodness as by wickedness." Is not this weak and almost meaningless language? What is meant by "enthroning a lofty virtue" in the place of vice and crime? The phrase has a fine sound, but it seems to be a case of *præterea nihil.* What a man of science would like to see would be a society organized and governed according to the best knowledge of the time. He would like to see the laws of life and health respected, justice maintained among men, and free scope given to individual development. As to the lofty virtue which Miss Cobbe so strongly desiderates, the scientific man would like to do away with the necessity for it by a general leveling up of human life. He believes, with Jean Jacques Rousseau, that prudence is a virtue which enables us to dispense with many others; and that, if the human race could be taught prudence, great reformers and missionaries might have an easy time of it, and perhaps be enabled to practice a little of their charity at home—an excellent starting-point, according to the proverb. The scientific man's ideal is necessarily a prosperous community of fairly self-sufficing individuals, not a world of misery lightened by the angel visitations and exertions of a few heroic souls. Some may think his ambition a low one, but he does not feel it to be so himself; he does not really see how any one who wishes well to the mass of his fellow-men can have any different ambition.

"Another threatening evil from the side of science is the growth of a hard and pitiless temper." So Miss Cobbe; and this in face of the fact that never in the history of the world was there so much sympathy with suffering, or so ready a recognition of the rights of humanity, as there is to-day. Reference is made to certain vague charges brought in an anonymous book against hospital physicians and students; but, even admitting these charges as true in some substantial measure—and we should be sorry to do so without further proof—no good reason can be assigned for charging on the scientific world at large a morbid temper displayed by a few representatives of one single profession. Compare the average practicing physician of to-day with the Slops and Sangrados of former times, and we fancy there is no visible falling off in humanity or any other respectable quality. What can not be denied is that science has done a great work in mitigating suffering and lengthening human life; and it would be strange indeed if the ministers of these benefits were themselves indifferent to the very objects of their labors.

Finally, joining hands with M. de Laveleye, Miss Cobbe declares that science destroys religion. The only reply to give on this point is just this: that, if science and religion are natural enemies, one must destroy the other; that if they are not, if each has its basis in nature, then neither will destroy the other; but, after a mutual adjustment of their claims, each will confirm and strengthen the other. Science is nothing else than knowledge of the facts and laws of the universe. If religion can not survive the acquisition of such knowledge by mankind, then it must perish; but we should be sorry to affirm that its position is so precarious. One thing is certain, Science can not go back. She has begun a series of interpretations of the great book of Nature that prove to be of ever-increasing interest from year to year. She can not stop in this career. The book has only been fairly opened; the true key to its hieroglyphs has just been found; the practical results already achieved by means of the knowledge acquired are full of advantage in the present and of promise for the future; what is there to do, therefore, but to go forward? Men of science may, as individuals, fall into many errors. They may fail to realize the true dignity of their calling; they may be unduly swayed by party spirit or by personal aims; they may be unworthy ministers of the truths which they deliver. But science, what is it but truth? And what is the scientific spirit but the spirit that bows to truth? To all who are dissatisfied with the present currents of thought we would, therefore, say: "Criticise men as much as you please. Point out their errors, their failings, intellectual and moral, with all needful severity. Hold up the standard by which you think their lives and thoughts ought to be governed. Criticise theories, too. Let nothing pass unchallenged or unscrutinized that you are not satisfied is true. Let no glamour of great names, no popularity of certain modes of thought, deter you from expressing your dissent from what you do not believe. But do not put yourselves hopelessly in the wrong by attacking science, or by abusing the scientific spirit. You will gain nothing by it, but will merely darken your understandings, and shut yourselves out from the light that is ready to lighten every man that comes into the world. Science will abide. It has its roots in the everlasting rocks, and draws its aliment from universal nature. The scientific spirit will abide, admonishing men of their errors, and leading them into all truth. It is wise to be reconciled to such powers as these; even now, while you are in the way with them, make terms of peace, and find rest to your souls."

THE SUANETIANS AND THEIR HOME.*

By DOUGLAS W. FRESHFIELD.

A NEW recreation-ground is wanted for those of our countrymen who, without being travelers by profession, find pleasure and refreshment in rough travel among primitive people, in mountain scenery and glacier air, in that sense of adventure and discovery which is afforded only by unknown countries or virgin heights, and on unmapped snowy chains. To such travelers—or vacation tourists—I offer the Caucasus. Here, if they make a hobby of map construction and correction, or of any branch of natural science, or of linguistic and ethnological studies, they will find a field for much useful work. At any rate, they may enjoy themselves, and while they do so they can hardly fail to increase knowledge. The country has been brought well within the reach of vacation tourists, of every one with a two months' holiday.

Nineteen years ago I described the first journey of exploration made by mountaineers, in the technical sense of that word, in the Caucasus, the ascents of its two most famous peaks, Elbruz and Kazbeck, and the general character of the snowy-chain that connects them. In July, 1887, in the company of M. de Déchy, and with Alpine guides, I revisited this noble chain, twice crossed some of its greatest glaciers, climbed several of its peaks, and penetrated many hitherto unknown recesses. In the course of these wanderings the mazes of the central group were unraveled, and several orographical problems which had puzzled intermediate travelers received their final solution.

For the moment I propose to limit myself to some notes on the scenery and people of a single district of the Caucasus, the mountain-girt basin of Suanetia, and one or two sketches of travel among its glaciers and snow-fields. Suanetia is the upper basin of the Ingur, a river which flows into the Black Sea a few miles east of Sukkum Kaleh. It is about the size of the valley of Aosta, forty miles long by fifteen broad. It lies between three thousand and seven thousand feet above the sea. On its north run the snowy ramparts of the Caucasian crest, inclosing in their complicated ridges four great glacier basins, and sending down more directly toward the Ingur or its tributaries many ice-streams, such as the Adish, which would be ranked in the Alps as glaciers of the first class. These ridges are composed of crystalline rocks, which show the tendency, observable in the Alps (e. g., in the Mont Blanc and Pelvoux groups), to arrange their

* From a paper read before the Royal Geographical Society, March 12, 1888.

summits in double lines, in the troughs between which lie vast *névés*. On either flank of the rigid granites lie beds of friable schists, whose green, rounded outlines afford a striking contrast to the snowy precipices of the great chain on which they abut. On the south Suanetia is fenced in by the lofty slate ridge of the Leila, which, running parallel to the main chain, attains a height of over twelve thousand feet, and bears very considerable glaciers toward its western end. In this direction the river escapes, between high spurs of the two chains, through a narrow porphyritic gorge, which is not at present passable for horses. On the east a low, grassy down (eight thousand six hundred feet), only sixteen hundred feet above the highest villages, leads into a pathless maze of forests and flowers—the wilderness in which the Skenes Skali, a tributary of the Rion, has its sources. Within these ridges and gorges the inhabitants have lived for centuries, isolated from the outer world, forgetting and forgotten.

They are first mentioned by Strabo, under the name of Soani, as a powerful nation; but Suaneti, as far as I could learn, is what they now call themselves. At the last census they numbered about twelve thousand. Over one third of the race, known from the native prince who ruled over them as the Dadian's Suanetians, live on the upper Skenes Skali. They have been more or less merged in the surrounding Mingrelian populations. The Suanetians are mentioned by Pliny and Procopius. Their country was reserved by Chosroes for Persia in his treaty with Justinian. It was converted to Christianity before the tenth century, and covered with small chapels or churches. Seven hundred years ago it formed part of the kingdom of Queen Thamara, the heroine who occupies the place of Alexander or Charlemagne in Georgian legend. The Suanetians still chant ballads in her honor. Suanetia soon fell off from the Georgian kingdom. It became, at some time in the last century, wholly unattached. Since that time the district has enjoyed a complete form of communal rule. Each community is made up of several villages, originally consisting each of members of the same family or *gens*, but now including several families. Members of the same family can not intermarry. Women and pasturage rights have been occasions of many feuds and vendettas. When a woman changed hands or husbands, the parties concerned could not always agree on the value in cattle—the Suanetians had no money—of the lady exchanged. Hence arose assaults of persons and batteries of towers. The affairs of the hamlet, so far as they were not settled by appeals to arms, were regulated by an assembly of adult males, in which unanimity was required for a valid decision. The foreign relations of the Suanetians consisted, for the most part, in predatory excursions into their neighbors' pastures. They were arrant sheep-stealers and cattle-lifters. Strangers met with no hospitality. On the contrary, it was the custom to exact a payment from them for passage, and the custom still survives in petty demands made for halting in a remote village. The Suanetians may fairly be described as reverted pagans. Some Christian rites—fasting in Lent, and the use of the sign of the cross—they have doubtless preserved. But these survivals seem to me no more to entitle them to the name of Christians than our own midsummer-night fires constitute us sun-worshipers. The country is covered with small churches and chapels, dating probably from the eleventh and twelfth centuries, built, unlike the houses and towers, of regularly squared blocks of limestone; the apse is sometimes ornamented externally with carving or an arcade of columns in low relief. The bells, as in Corsica, are suspended from a wooden frame outside the church. The altar-screens are arranged as in Greek churches. Long before Suanetia had obtained home-rule, it had advanced to church disestablishment. The priests disappeared, and their place was taken by a hereditary caste of local elders, who superintended the village feasts and sacrifices. The ecclesiastical property was secularized; a village vestry assumed its control, and kept the key of the church, which, no longer reserved for pious uses, served principally as a treasure-house. Inside, in heavy chests, were stored the sacred books and images—some of them beautiful works of art—Persian silks, strange three-sided pieces of wood, carved with old Georgian inscriptions, flint-headed spears and arrows, and dozens of horns of the Caucasian *tur*. These things are still kept locked up, and it is almost impossible for any stranger to see them. The priests having been disposed of, services and sacraments naturally went too. Marriage consisted in sewing together the garments of the bride and bridegroom; baptism was travestied; the ancient funeral ceremonies were revived or continued. Many graves surround the churches, but others are found under particular trees. It is obvious that tree-worship survives in Suanetia. In the center of many hamlets there is a venerable tree or trunk—walnut, birch, or cherry—under which stand two or three rude chairs. Doubtless these are old places of assembly. The people are said (on the authority of a Mingrelian priest) to venerate the heavenly bodies. The Suanetians who carried our goods over the chain, appeared to pray to and praise the sun directly. They do no work on Friday, Saturday, or Sunday, thus partially making up for their shortcomings by keeping the Sabbaths of three religions.

The Suanetians had home-rule and church disestablishment and disendowment. They had solved another pressing problem: they had, without emigration, overcome the natural tendency of the population to increase beyond the limits that their territory would support. They had even caused it to diminish. Their system was simple and effectual. They put a pinch of ashes, at birth, into the mouths of all superfluous female babies. They took a masculine view of superfluity. At the last census there were four males to three females in the Ingur Valley.

Poetry, where it exists—above all, primitive poetry and local ballads—often gives a nearer insight into the condition of life and manners of a race than religious rites and beliefs. Dr. Radde has fortunately preserved a number of very curious Suanetian ballads, such as are still sung under some ancient tree, or on the march along the mountain-path. They celebrate the golden time of Thamara, past forays across the great chain into the lands of the Baksan Tartars, or among the Abkasians to the west.

Under Russian rule a change is slowly coming over the people; schools, perhaps the only effectual civilizers, are doing their work. Everywhere I noticed in the rising generation an absence of the wild-animal expression which was the characteristic of the free Suanetians twenty years ago, and which all travelers have observed.

The Suanetians are not mainly a pastoral people. They keep a few flocks of sheep and herds of horses. Bullocks are used to draw sledges, and are eaten in winter. But flocks and herds are seldom found, as among the Tartars beyond the chain, on the high pastures, and consequently there are no paths to them. To reach the upper glacier basins you must find and follow almost untraceable hunters' tracks. Pigs, the smallest breed I ever saw, and geese wander round the homesteads, which are guarded by dogs. The villages are surrounded by barley-fields fenced in with neat wattling. The paths between them are pleasant, and less stony than most Alpine mule-roads. The inhabitants have learned to cultivate potatoes and other vegetables. They cut a certain amount of hay on the high pastures. Sometimes they cross the chain in summer, and let themselves out as laborers to the indolent Tartars; but there is no love lost between them. The Mussulmans look on the Suanetians with contempt as pig-eaters. I heard the Suanetians hiss "Cherkess!" at our Kabardan Cossack; and the Cossack—a mild and amiable creature, the reverse of the popular idea of a Cossack—despised and distrusted every Suanetian from the bottom of his soul. A race-hatred of centuries was recognizable in its ashes.

Variety is the marked type characteristic of the Suanetians. One village head-man, huge and bull-like, was like a figure from an Assyrian monument. Of the three men who led our baggage-horses from Ushkul, one wore the clothes and had something of the air and manners of a Persian gentleman. Another was a splendid, good-tempered, fair giant. Fair men with tawny heads are common. The third was a tattered, dark, stumpy, noisy barbarian. The costumes and manners of the women are various.

After its natural beauties, its peaks and forests, what strikes the traveler in Suanetia is the local architecture. The castellated villages which lawlessness has produced are as prominent in his eyes as the castles of the robber barons are to the Rhine tourist, or the towers of San Gemignano to those who wander in Italian by-ways. Nothing more strangely fantastic can be imagined than these towered hamlets. Mestia alone has seventy towers, from forty to eighty feet high, Ushkul about fifty, and two castles besides. Let me try to describe, from a sketch, a street scene in Chubiani, one of the hamlets of Ushkul, seven thousand feet above the sea. The house is a square block, built of irregular pieces of slate and slate-roofed. The only windows are small holes, high up, and unclosed. The smoke escapes through the roof. Birch-bark torches are used at night. A wooden passage, capable of being cut down in case of emergency, leads to the tower of refuge. Let us enter the house: it consists of one large ill-lighted room; two or three rude stones form the hearth; there are a few rough wooden benches and stools on the earthen floor; in the corner is a raised wooden platform with skins and cushions, the family couch. Groping up a dark passage, we reach the tower. Ladders, easily removable, reach from story to story. The ladders are short, and to gain each story one is compelled to scramble up projecting stones left in the wall. Skulls of wild goats, and other odds and ends, lie about on the landings. On the top story are loop-holes for firing. These towers, unlike the churches, are built of untrimmed black slates, generally whitewashed. At Ushkul, however, there are two castles, one fifty the other five hundred feet above the village (attributed, of course, to Queen Thamara), in which the black slate has been left in its native color. In the lower castle I found a ruined chapel. The higher castle commands a view of the pass to the Upper Skenes Skali, and must have been the defense of this entrance to the valley. M. Bussanio Nichoradse, a native of Ushkul, and a schoolmaster, told me that in ancient times all the families in a village were bound to assist their neighbor who was building a tower, but that no new towers had been raised, though many had been repaired, within his memory. A somewhat similar custom existed in the present generation at Chamounix.

"Savage Suanetia," the title chosen by an enthusiastic sportsman for the most recent description of this district, although in one sense appropriate, seems to me, so far as nature is concerned, singularly unhappy. Smiling, sylvan—such are the epithets that come naturally to the traveler's lips as he suddenly emerges from the icy regions of the Caucasus into the wooded hills, gentle slopes, sunny meadows, and neatly fenced barley-fields. Compared with the warrens or stone-heaps which serve the Tartars of the northern valleys for dwellings, even the towered villages have at a distance a false air of civilization. Suanetia in June, in the flower-time of the rhododendrons and azaleas, and again in October, when the azalea-leaves are red, and the birches golden against fresh autumn snows, must be one of the wonders of the world. Spaciousness, sunniness, variety, are the constant qualities of Suanetian landscapes. The great basin of the Ingur, forty miles long by ten to fifteen broad, is broken by no ridges that approach the snow-line, and the long, undulating, grassy spurs that divide the glens, in place of narrowing the horizon, furnish in their soft lines the most effective contrast possible to the icy peaks and rigid precipices of Shkara and Tetnuld, of Ushbe and the Leila. From the varied beauty of forests and flowers the eyes are carried at once to the pure glaciers, which hang like silver stairs on the green lower slopes of the snowy chain. The atmosphere has none of the harshness of that of Switzerland in summer. The breezes from the Black Sea bring up showers and moisture to soften the outlines and color the distances; the wind from the steppe suffuses the air with an impalpable haze, through which the great peaks glimmer like golden pillars of the dawn.

THE HISTORY OF A DOCTRINE.*

By Prof. S. P. LANGLEY.

II.

THE first five years of this century are notable in the history of radiant energy, not only for the work of Leslie, and for the observation by Wollaston, Ritter, and others, of the so-called "chemical" rays beyond the violet, but for the appearance of Young's papers, re-establishing the undulatory theory, which he indeed considered in regard to light, but which was obviously destined to affect most powerfully the theory of radiant energy in general.

We are now in the year 1804, or over a century and a quarter since the corpuscular theory was emitted, and during that time it has gradually grown to be an article of faith in a sort of scientific church, where Newton has come to be looked on as an infallible head, and his views as dogmas, about which no doubt is to be tolerated; but if we could go back to Cambridge in the year 1668,

* President's address before the American Association for the Advancement of Science, at Cleveland, Ohio, August 15, 1888. Reprinted from "Science."

when the obscure young student, in no way conscious of his future pontificate, takes his degree (standing twenty-third on the list of graduates), we should probably find that he had already elaborated certain novel ideas about the undulatory theory of light, which he at any rate promulgates a few years later, and afterward, pressed with many difficulties, altered, as we now know, to an emissive one.

Probably, if we could have heard his own statement then, he would have told how sorely tried he was between these two opinions, and, while explaining to us how the wavering balance came to lean as it did, would have admitted, with the modesty proper to such a man, that there was a great deal to be said on either side. We may, at any rate, be sure that it would not be from the lips of Newton himself that we should have had this announced as a belief which was to be part of the rule of faith to any man of science.

But observe how, if Science and Theology look askance at each other, it is still true that some scientific men and some theologians have, at any rate, more in common than either is ready to admit; for at the beginning of this century Newton's followers, far less tolerant than their master, have made out of this modest man a scientific pontiff, and out of his diffident opinions a positive dogma, till, as years go on, he comes to be cited as so infallible that a questioning of these opinions is an offense deserving excommunication.

This has grown to be the state of things in 1804, when Young, a man possessing something of Newton's own greatness, ventures to put forward some considerations to show that the undulatory theory may be the true one, after all. But the prevalent and orthodox scientific faith was still that of the material nature of light; the undulatory hypothesis was a heresy, and Young a heretic. If his great researches had been reviewed by a physicist or a brother worker, who had himself trodden the difficult path of discovery, he might have been treated at least intelligently; but, then, as always, the camp-followers, who had never been at the front, shouted from a safe position in the rear to the man in the dust of the fight, that he was not proceeding according to the approved rules of tactics; then, as always, these men stood between the public and the investigator, and distributed praise or blame.

If you wish to hear how the scientific heretic should be rebuked for his folly, listen to one who never made an observation, but, having a smattering of everything books could teach about every branch of knowledge, was judged by himself and by the public to be the fittest interpreter to it, of the physical science of his day. I mean Henry Brougham, the future Lord-Chancellor of England, the universal critic, of whom it was observed that, "if he had but known a little law, he would have known a little of everything."

He uses the then all-powerful "Edinburgh Review" for his pulpit, and notices Young's great memoir as follows: "This paper contains nothing which deserves the name either of experiment or discovery; and it is, in fact, destitute of every species of merit. . . . The paper which stands first is another lecture, containing more fancies, more blunders, more unfounded hypotheses, more gratuitous fictions, . . . and all from the fertile yet fruitless brain of the eternal Dr. Young. In our second number we exposed the absurdity of this writer's 'law of interference,' as it pleases him to call one of the most incomprehensible suppositions that we remember to have met with in the history of human hypotheses."

There are whole pages of it, but this is enough; and I cite this passage among many such at command, not only as an example of the way the undulatory theory was treated at the beginning of this century in the first critical journal of Europe, but as another example of the general fact that the same thing may appear intrinsically absurd, or intrinsically reasonable, according to the year of grace in which we hear of it. The great majority, even of students of science, must take their opinions ready-made as to science in general; each knowing, so far as he can be said to know anything at first hand, only that little corner which research has made specially his own. The moral we can all draw, I think, for ourselves.

In spite of such criticism as this, the undulatory hypothesis of light made rapid way, and carried with it, one would now say, the necessary inference that radiant heat was due to undulations also. This was, however, no legitimate inference to those to whom radiant heat was still a fluid; and yet, in spite of all, the modern doctrine now begins to make visible progress.

A marked step is taken about 1811 by a young Frenchman, De la Roche, who deserves to be better remembered than he is, for he clearly anticipated some of Melloni's discoveries. De la Roche in particular shows that of two successive screens the second absorbs heat in a less ratio than the first; whence he, before any one else, I believe, derives the just and most important, as well as the then most novel conception, that radiant heat is of different kinds. He sees also that, as a body is heated more and more, there is a gradual and continual advance not only in the amount of heat it sends out, but in the kind, so that, as the temperature still rises, the radiant heat becomes light by imperceptible gradations; and he concludes that heat and light are due to one simple agent, which, as the temperature rises yet more, appears more and more as light, or which, as the luminous radiation is absorbed, reappears as heat. Very little of it, he observes, passes even transparent screens at low temperatures, but more and more does so as the temperature rises. All this is a truism in 1888, but it is admirably new as well as true in 1811; and if De la Roche had not been removed by an early death, his would have not improbably been the greatest name of the century in the history of our subject; an honor, however, which was in fact reserved for another.

The idea of the identity of light and radiant heat had by this time made such progress that the attempt to polarize the latter was made in 1818 by Berard. We have just seen in Herschel's case how the most sound experiment may lead to a wrong conclusion, if it controverts the popular view. We now have the converse of this in the fact that the zeal of those who are really in the right way may lead to unsound and inconclusive experiment; for Berard experimentally established, as it was supposed, the fact that obscure radiant heat can be polarized. So it can, but not with such means as Berard possessed, and it was not till a dozen years more that Forbes actually proved it. At this time, however fairly we seem embarked on the paths of study which are followed to-day, and while the movement of the main body of workers is in the right direction, it is yet instructive to observe how eminent men are still spending great and conscientious labor, their object in which is to advance the cause, while the effect of it is to undo the little which has been rightly done, and to mislead those who have begun to go right.

As an instance both of this and of the superiority of modern apparatus, we may remark—after having noticed that the ability of obscure heat to pass through glass, if completely established, would be a strong argument in favor of its kinship to light, and that De la Roche and others had indicated that it would do so (in which we now know they were right)—that at this stage, or about 1816, Sir David Brewster, the eminent physicist, made a series of experiments which showed that it would not so pass. Ten years later, in view of the importance of the theoretical conclusion, Baden Powell repeated his observations with great care, and confirmed them, announcing that the earlier experimenters were wrong, and that Brewster was right. Here all these years of conscientious work resulted in establishing, so far as it could be established, a wholly wrong conclusion in place of a right one already gained. It may be added that, with our present apparatus, the passage of obscure radiant heat through glass could be made convincingly evident in an experiment which need not last a single second.

We are now arrived at a time when the modern era begins; and in looking back over one hundred and fifty years, from the point of view of the experimenter himself, with his own statement of the truth as he saw it, we find that the comparison of the progress of science to that of an army, which moves, perhaps with the loss of occasional men, but on the whole victoriously and in one direction, is singularly misleading; and I state this more confidently here, because there are many in this audience who did not get their knowledge of nature from books only, but who have searched for the truth themselves; and, speaking to them, may I not say that those who have so searched know that the most honest purpose and the most patient striving have not been guarantees against mistakes—mistakes which were probably hailed at the time as successes? It was some one of the fraternity of seekers, I am sure, who said, "Show me the investigator who has never made a mistake, and I will show you one who has never made a discovery."

We have seen the whole scientific body, as regards this particular science of radiant energy, moving in a mass, in a wrong direction, for a century; we have seen that individuals in it go on their independent paths of error; and we can only wonder that an era should have come in which such a real advance is made as in ours.

That era has been brought in by the works of many, but more than by any other through the fact that in the year 1801 there came into the world at Parma an infant who was born a physicist, as another is born a poet; nay, more; who was born, one might say, a devotee of one department of physics—that of radiant heat; being affected in his tenderest years with such a kind of precocious passion for the subject as the childish Mozart showed for music. He was ready to sacrifice everything for it; he struggled through untold difficulties, not for the sake of glory or worldly profit, but for radiant heat's sake; and when fame finally came to him, and he had the right to speak of himself, he wrote a preface to his collected researches, which is as remarkable as anything in his works. In this preface he has given us, not a summary of previous memoirs on the subject, not a table of useful factors and formulæ, not anything at all that an English or American scientific treatise usually begins with, but the ingenuous story of his first love, of his boyish passion for this beloved mistress; and all this with a trust in us his readers which is beautiful in its childlike confidence in our sympathy. I must abbreviate and injure in order to quote; but did ever a learned physical treatise and collection of useful tables begin like this before?—

"I was born at Parma, and when I got a holiday used to go into the country the night before and go to bed early, so as to get up before the dawn. Then I used to steal silently out of the house, and run, with bounding heart, till I got to the top of a little hill, where I used to set myself so as to look toward the east." There, he tells us, he used, in the stillness of nature, to wait the rising sun, and feel his attention rapt, less with the glorious spectacle of the morning light itself than with the sense of the mysterious heat which accompanied its beams, and brought something more necessary to our life and that of all nature than the light itself.

The idea that not only mankind, but nature, would perish though the light continued, if this was divorced from heat, made a profound impression, he tells us, on his childish mind. The statement that such an idea could enter with dominating force into the mind of a child will perhaps seem improbable to most. It will, however, be comprehensible enough to some here, I have no doubt.

Is there some ornithologist present who remembers a quite infantile attraction which birds possessed for him above all the rest of the animated creation; some chemist whose earliest recollections are of the strange and quite abnormal interest he found as a child in making experimental mixtures of every kind of accessible household fluid and solid; some astronomer who remembers when a very little creature that not only the sight of the stars, but of any work on astronomy, even if utterly beyond his childish comprehension, had an incomprehensible attraction for him? I will not add to the list. There are, at any rate, many here who will understand and believe Melloni when he tells how this radiant heat, commonplace to others, was wonderful to his childish thought, and wrought a charm on it such that he could not see wood burn in a fireplace, or look at a hot stove, without its drawing his mind, not to the fire or iron itself, but to the mysterious effluence which it sent.

This was the youth of genius; but let not any fancy that genius in research is to be argued from such premonitions alone, unless it can add to them that other qualification of genius which has caused it to be named the faculty of taking infinite pains. Melloni's subsequent labors justified this last definition also; but I can not speak of them here, further than to say that, after going over a large part of his work myself, with modern methods and with better apparatus, he seems to me the man, of all great students of our subject, who, in reference to what he accomplished, made the fewest mistakes.

Melloni is very great as an experimenter, and owes much of his success to the use of the newly invented thermopile, which is partly his own. I can here, however, speak only of his results, and of but two of these—one generally known; the other, and the more important, singularly little known, at least in connection with him. The first is the full recognition of the fact, partly anticipated by De la Roche, that radiant heat is of different kinds, that the invisible emanations differ among themselves just as those of light do. Melloni not only established the fact, but invented a felicitous term for it, which did a great deal to stamp it on recognition—the term "thermochrose," or heat-color, which helps us to remember that, as the visible and apparently simple emanation of light is found to have its colors, so radiant heat, the invisible but apparently simple emanation, has what would be colors to an eye that could see them. This result is well known in connection with Melloni.

The other and the greater, which is not generally known as Melloni's, is the generalization that heat and light are effects of one and the same thing, and merely different manifestations of it. I translate this important statement as closely as possible from his own words. They are that "*Light is merely a series of calorific indications sensible to the organs of sight, or Vice Versa, the radiations of obscure heat are veritable* INVISIBLE RADIATIONS *of light.*" The italics and the capitals are Melloni's own. He wishes to have no ambiguity about his announcement behind which he may take shelter; and he had so firm a grasp of the great principle that, when his first attempts to observe the heat of the moon failed, he persevered, because this principle assured him that where there was light there must be heat. This statement was made in 1843, and ought, I think, to insure to Melloni the honor of being the first to distinctly announce this great principle. The announcement passed apparently unnoticed, in spite of his acknowledged authority; and the general belief not merely in different entities in the spectrum, but in a material caloric, continued as strong as ever. If you want to see what a hold on life error has, and how hard it dies, turn to the article "Heat," in the eighth edition of the "Encyclopædia Britannica," where you will find the old doctrine of caloric still in possession of the field in 1853; and still later, in the generally excellent "English Encyclopædia" (edition of 1867), the doctrine of caloric is, on the whole, preferred to the undulatory hypothesis. It is very probable that a searcher might find many traces of it yet lingering among us; so that Giant Caloric is not, perhaps, even yet quite dead, though certainly grown so crazy, and stiff in the joints, that he can now harm pilgrims no more.

So far as I know, no physicist of eminence reasserted Melloni's principle till J. W. Draper, in 1872. Only sixteen years ago, or in 1872, it was almost universally believed that there were three different entities in the spectrum, represented by actinic, luminous, and thermal rays. Draper remarks that a ray consists solely of ethereal vibrations whose lost *vis viva* may produce either heat or chemical change. He uses Descartes's analogy of the vibration of the air, and sound; but he makes no mention either of Descartes or of Melloni, and speaks of the principle as leading to a modification of views then "universally" held. Since that time the theory has made such rapid progress that, though some of the older men in England and on the European continent have not welcomed it, its adoption among all physicists of note may be said to be now universal, and a new era in our history begins with it. I mean by the recognition that there is one radiant energy which appears to us as "actinic," or "luminous," or "thermal" radiation, according to the way we observe it. Heat and light, then, are not things in themselves, but, whether different sensations in our own bodies or different effects in other bodies, are merely effects of this mysterious thing we call radiant energy, without doing more in this than give a name to the ignorance which still hangs over the ultimate cause.

I am coming down dangerously near our own time—dangerously for one who would be impartial in dealing with names of those living and with controversies still burning. In such a brief review of this century's study of radiant energy in other forms than light, it has been necessary to pass without mention the labors of such men as Pouillot and Becquerel in France, of Tyndall in England, and of Henry in America. It has been necessary to omit all mention of those who have advanced the knowledge of radiant energy as light, or I should have had to speak of labors so diverse as those of Fraunhofer, of Kirchhoff, of Fresnel, of Stokes, of Lockyer, and many more. I have made no mention, in the instructive history of error, of many celebrated experimental researches; in particular of such a problem as the measurement of solar heat, great in importance, but apparently most simple in solution, yet which has now been carried on from generation to generation, each experimenter materially altering the result of his predecessor, and where our successors will probably correct our own results in time. I have not spoken of certain purely experimental investigations, like those of Dulong and Petit, which have involved immense and conscientious labor, and have apparently rightly earned the name of "classic" from one generation, only to be recognized by the next as leading to wholly untrustworthy results, and leaving the work to be done again with new methods, guided by new principles.

In these instances, painstaking experiments have proved insufficient, less from want of skill in the investigator than from his ignorance of principles not established in time to enable him to interpret his experiments; but, if there were opportunity, it would be profitable to show how inexplicably sometimes error flourishes, grows, and maintains an apparently healthy appearance of truth, without having any root whatever. Perhaps I may cite one instance of this last from my own experience. About fifteen years ago it was generally believed that the earth's atmosphere acted exactly the part of the glass in a hot-bed, and that it kept the planet warm by exerting a specially powerful absorption on the infra-red rays.

I had been trained in the orthodox scientific church, of which I am happy to be still a member; but I had acquired perhaps an almost undue respect, not only for her dogmas, but for her least sayings. Accordingly, when my own experiments did not agree with the received statement, I concluded that my experiments must be wrong, and made them all over again, till spring, summer, autumn, and winter had passed, each season giving its own testimony; and this for successive years. The final conclusion was irresistible, that the universal statement of this alleged well-known fact (inexplicable as this might seem, in so simple a matter) was directly contradicted by experiment.

I had some natural curiosity to find how every one knew this to be a fact; but search only showed the same statement (that the earth's atmosphere absorbed dark heat like glass) repeated everywhere, with absolutely nowhere any observation or evidence whatever to prove it, but each writer quoting from an earlier one, till I was almost ready to believe it a dogma superior to reason, and resting on the well-known "*Quod semper, quod ubique, quod ab omnibus, creditum est.*"

Finally, I appear to have found its source in the writings of Fourier, who, alluding to De Saussure's experiments (which showed that dark heat passed with comparative difficulty through glass), observes that, if the earth's atmosphere were solid, it would act as the glass does. Fourier simply takes this (in which he is wholly wrong) for granted; but as he is an authority on the theory of heat, his words are repeated without criticism, first by Poisson, then by others, and then in the text-books; and, the statement gaining weight by age, it comes to be believed absolutely, on no evidence whatever, for the next sixty years, that our atmosphere is a powerful absorber of precisely those rays which it most freely transmits.

The question of fact here, though important, is, I think, quite secondary to the query it raises as to the possible unsuspected influence of mere tradition in science, when we do not recognize it as such. Now, the Roman Church is doubtless quite logical in believing in traditions, if these are recommended to the faithful by an infallible guide; but are we, who have no infallible guide, quite safe in believing all we do, with our fond persuasion that in the scientific body mere tradition has no weight?

In even this brief sketch of the growth of the doctrine of radiant energy, we have perhaps seen that the history of the progress of this department of science is little else than a chapter in that larger history of human error which is still to be written, and which, it is safe to say, would include illustrations from other branches of science as well as my own.

But—and here I ask pardon if I speak of myself—I have been led to review the labors of other searchers from this standpoint, because I had first learned, out of personal experience, that the most painstaking care was no guarantee of final accuracy; that to labor in the search for a truth with such endless pains as a man might bestow if his own salvation were in question did not necessarily bring the truth; and because, seeking to see whether this were the lot of other and greater men, I have found that it was, and that, though no one was altogether forsaken of the Truth he sought (or, on the whole review of his life as a seeker, but might believe he had advanced her cause), yet there was no criterion by which it could be told at the time whether, when after long waiting there came in view what seemed once more her beautiful face, it might not prove, after all, the mockery of error; and probably the appeal might be made to the experience of many investigators here with the question, "Is it not so?"

What then? Shall we admit that truth is only to be surely found under the guidance of an infallible church? If there be such a church, yes! Let us, however, remember that the church of science is not such a one, and be ready to face all the consequences of the knowledge that her truths are put forward by her as provisional only, and that her most faithful children are welcome to disprove them. What then, again? Shall we say that the knowledge of truth is not advancing? It is advancing, and never so fast as to-day; but the steps of its advance are set on past errors, and the new truths become such stepping-stones in turn.

To say that what are truths to one generation are errors to the next, or that truth and error are but different aspects of the same thing to our poor human nature, may be to utter truisms; but truisms which one has verified for one's self out of a personal experience are apt to have a special value to the owner; and these lead, at any rate, to the natural question, "Where is then the evidence that we are advancing in reality, and not in our own imagination?"

There are many here who will no doubt heartily subscribe to the belief that there is no absolute criterion of truth for the individual, and admit that there is no positive guarantee that we, with this whole generation of scientific men, may not, like our predecessors, at times go the wrong way in a body, yet who believe as certainly that science as a whole, and this branch of it in particular, is advancing with hitherto unknown rapidity. In asking to be included in this number, let me add that to me the criterion of this advance is not in any ratiocination, not in any *a priori* truth, still less in the dictum of any authority, but in the undoubted observation that our doctrine of radiant energy is reaching out over nature in every direction, and proving itself by the fact that through its aid nature obeys us more and more; proving itself by such material evidence as is found in the practical applications of the doctrine, in the triumphs of modern photography, in the electric lights in our streets, and in a thousand ways which I will not pause to enumerate.

And here I might end, hoping that there may be some lessons for us in the history of what has been said. I will venture to ask the attention to one more, perhaps a minor one, but of a practical character. It is that in these days, when the advantage of organization is so fully realized, when there is a well-founded hope that by co-operation among scientific men knowledge may be more rapidly increased, and when in the great scientific departments of government and elsewhere there is a tendency to the formation of the divisions of a sort of scientific army—a tendency which may be most beneficially guided—that at such a time we should yet remember that, however rapidly science changes, human nature remains much the same; and (while we are uttering truisms) let us venture to say that there is a very great deal of this human nature even in the scientific man, whose best type is one nearly as unchanging as this nature itself, and one which can not always advantageously be remodeled into a piece of even the most refined bureaucratic mechanism, but will work effectively only in certain ways, and not always at the word of command, nor always best in regiments, nor always best under the best of discipline.

Finally, if I were asked what I thought were the next great steps to be taken in the study of radiant heat, I should feel unwilling to attempt to look more than a very little way in advance. Immediately before us, however, there is one great problem waiting solution. I mean the relation between temperature and radiation; for we know almost nothing of this, where knowledge would give new insight into almost every operation of nature, nearly every one of which is accompanied by the radiation or reception of heat, and would enable us to answer inquiries now put to physicists in vain by every department of science, from that of the naturalist as to the enigma of the brief radiation of the glow-worm, to that of the geologist who asks as to the number of million years required for the cooling of a world.

When, however, we begin to go beyond the points which seem, like this, to invite our very next steps in advance, we can not venture to prophesy; for we can hardly discriminate among the unlimited possibilities which seem to open before a branch of knowledge which deals especially with that radiant energy which sustains, with our own being, that of all animated nature, of which humanity is but a part. If there be any students of Nature here, who, feeling drawn to labor in this great field of hers, still doubt whether there is yet room, surely it may be said to them, "Yes, just as much room as ever, as much room as the whole earth offered to the first man"; for that field is simply unbounded, and everything that has been done in the past is, I believe, as nothing to what remains before us.

The days of hardest trial and incessant bewildering error in which your elders have wrought seem over. You "in happier ages born," you of the younger and the coming race, who have a mind to enter in and possess it, may, as the last word here, be bidden to indulge in an equally unbounded hope.

[*Concluded.*]

GAUSS AND THE ELECTRIC TELEGRAPH.

WE have been favored with the following interesting letter, giving some facts in relation to Prof. Gauss in addition to the sketch of this distinguished mathematician which appeared in "The Popular Science Monthly" for September, 1888, and inclosing the appended extracts from letters by Gauss in regard to his invention of a form of electric telegraph:

DENVER, COLORADO, *October 24, 1888.*

DR. W. J. YOUMANS, *New York.*

DEAR SIR: Please allow me, as a grandson of Carl Friedrich Gauss, the German mathematician, to thank you for the sketch of his life and works which appeared in the September number of "The Popular Science Monthly." I should have made this acknowledgment long ago, and intended doing so, but for various reasons postponed it from time to time, for which I beg your pardon.

There are two slight errors in your article, one, at least, of which is hardly worth mentioning. The first is in regard to the date of Prof. Gauss's birth. "The Popular Science Monthly" article says that he was born on April 23, 1777. In fact, however, he was born on April 30th of that year.

The other error amounts to little, but perhaps you may think it worth correcting. You say that he and Prof. Weber sent telegraphic signals from Göttingen to a neighboring town. They were, in fact, sent only from the astronomical observatory to the physical cabinet, which was under the direction of Prof. Weber; this was in 1833. The wire used was about eight thousand feet long; it was destroyed by a stroke of lightning in 1845. On pages 64 and 65 of "Gauss zum Gedächtniss," by W. Sartorius von Waltershausen, there is a description of this telegraphic line. In a work entitled, I believe, "Electricity in the Service of Man," there is a picture of the telegraphic apparatus used by Gauss and Weber.

Inclosed herewith I send you a translation of parts of two letters written by Gauss in regard to the telegraph; they will explain themselves. I also send a copy of the original, for possibly the translation is not wholly correct. The last letter written by Prof. Gauss was to Sir David Brewster, in relation to the early discovery of the electric telegraph. I have tried to obtain either the original or a copy of this letter, but thus far I have not succeeded. I regret this all the more, for the reason that I believe it would be of interest to the public if it were published.

It may be of interest to you to know that one of Prof. Gauss's children is still living. He is my father, and he resides in the country a short distance from the town of Columbia, Mo. He is now in his seventy-eighth year. His name is Eugene. Another son, William, came to America about 1836, and died in St. Louis, Mo., in 1879. Gauss's youngest child, a daughter named Theresa, resided with her father in Göttingen at the time of his death. She herself died about twenty years ago in Europe. These were children by his second marriage. Also, by his first marriage, Gauss had two sons and one daughter. The oldest, Joseph, became "Oberbaurath" of Hanover. He died in the city of Hanover in 1873. The daughter, Minna, became the wife of Prof. Ewald, the author of a "History of the People of Israel" and a number of commentaries on different books of the Old Testament. As a Hebraist he ranked as high as, I believe, if not higher than, Gauss as a mathematician. The youngest of the children by the first marriage, Louis, died in infancy. Ewald's wife died in 1840. None of Gauss's descendants have exhibited remarkable talent in any way.

I trust I have not wearied you with these family matters.

Very truly, etc., R. GAUSS.

P. S.—By the way, Prof. Weber is still living, and to-day is his birthday. He is eighty-four years old.

At a meeting of the Electro-Technic Association held in Berlin in 1883, Prof. W. Forster, director of the Berlin Observatory, read the following extracts from letters written by Prof. C. F. Gauss, of Göttingen, in relation to the early invention of the electric telegraph:

"I don't remember," writes Gauss to Olbers, on the 20th of November of the year 1833, "my having made any previous mention to you of an astonishing piece of mechanism that we have devised. It consists of a galvanic circuit conducted through wires stretched through the air over the houses up to the steeple of St. John and down again, and connecting the observatory with the physical laboratory, which is under the direction of Weber. The entire length of wire may be computed at about eight thousand feet. Both ends of the wire are connected with a multiplicator, the one at my end consisting of one hundred and seventy, that in Weber's laboratory of fifty coils of wire, each wound around a one-pound magnet suspended according to a method which I have devised. By a simple contrivance—which I have named a commutator—I can reverse the current instantaneously. Carefully operating my voltaic pile, I can cause so violent a motion of the needle in the laboratory to take place that it strikes a bell, the sound of which is audible in the adjoining room. This serves merely as an amusement. Our aim is to display the movements with the utmost accuracy. We have already made use of this apparatus for telegraphic experiments, which have resulted successfully in the transmission of entire words and small phrases. This method of telegraphing has the advantage of being quite independent of either daytime or weather; the one who gives the signal and the one who receives it remain in their rooms, with, if they desire it, the shutters drawn. The employment of sufficiently stout wires, I feel convinced, would enable us to telegraph with but a single tap from Göttingen to Hanover, or from Hanover to Bremen."

The following remarks occur in a letter written by Gauss to H. C. Shumacher, dated August 6, 1835: "In more propitious circumstances than mine, important applications of this method could, no doubt, be made, enuring to the advantage of society and exciting the wonder of the multitude. With an annual budget of one hundred and fifty thalers for observatory and magnetic laboratory together (I make this statement to you in strictest confidence) no grand experiments can be made. Could thousands of dollars be expended upon it, I believe electro-magnetic telegraphy could be brought to a state of perfection, and made to assume such proportions as almost to startle the imagination. The Emperor of Russia could transmit his orders without intermediate stations, in a minute, from Petersburg to Odessa, even peradventure to Kiakhta, if a copper wire of sufficient strength were conducted safely across and attached at both ends to powerful batteries, and with well-trained managers at both stations. I deem it not impossible to design an apparatus that would render a dispatch almost as mechanically as a chime of bells plays a tune that has been arranged for it. One hundred millions' worth of copper wire would amply suffice for a continuous chain to reach the antipodes; for half the distance, a quarter as much, and so on, in proportion to the square of the distance."

At the same meeting the following dispatch was sent to Prof. William Weber, at Göttingen: "The Electro-Technic Association celebrates to-day the year 1883, as the fiftieth anniversary of the first successful operation of the electric telegraph, and salutes you as the still surviving associate in that great achievement. At the same time it expresses renewed homage for Gauss, who at that period, in conjunction with you at Göttingen, achieved so great a result, and at the same time clearly recognized the future of this creation."

THE SACRIFICE OF EDUCATION.

A PROTEST.

AS an indication of the present state of feeling in England toward the system of public education in that country, and especially toward the abuse of examinations, we reprint the following vigorous protest, which is signed by over a hundred professors and teachers, about seventy members of Parliament, and by members of the nobility, clergymen, and others, to the total number of four hundred. We omit the names for lack of space. The sentiments expressed in the protest are enforced in appended communications from Prof. Max Müller, Mr. E. A. Freeman, and Mr. Frederic Harrison, which it is our purpose to print next month:

We, the undersigned, wish to record our strong protest against the dangerous mental pressure and misdirection of energies and aims which are to be found in nearly all parts of our educational system. Alike in public elementary schools, in schools of all grades and for all classes, and at the universities, the same dangers are too often showing themselves under different forms. Children—as is so frequently insisted on—are treated by a public department, by managers and schoolmasters, as suitable instruments for earning Government money; young boys of the middle and richer classes are often trained for scholarships, with as little regard for the future as two-year-old horses are trained for races; and young men of real capability at the universities are led to believe that the main purpose of education is to enable them to win some great money prize, or take some distinguished place in an examination.

We protest emphatically against such a misdirection of education, and against the evils that necessarily arise from it.

We wish at the outset to call the attention of parents and teachers to the resulting physical mischief. One of the first duties of a child or young person is to grow well. In the rapid formation of new bone, muscle, and tissue of all kinds, Nature lays on a child a very heavy tax—a tax that should absorb the larger part of its surplus energy. It is probable that in the course of every year some valuable young lives are lost, in cases where this energy has been drawn away by mental overstrain from the work which it has primarily to perform, and where there is in consequence a failure of strength to meet the *sequelæ* of scarlet fever or other serious illness. Even in the great number of cases where no strongly marked ill-effect discloses itself during the years of youth, there are sufficient grounds for believing that what is unsparingly taken at this period of life is taken at the expense of future vigor and capability. It has, moreover, to be borne in mind that mental overpressure and brain irritation, on the one side, are likely, just as idleness and want of occupation the other, to increase among boys peculiar physical (and moral) dangers of a most serious character—dangers which are but little regarded by the public, but which always exist where boys are massed together.

We consider that, together with a general failure to keep steadily in view the true ends of education, great examinations and the valuable prizes attached to them are responsible for a large part of this overstrain placed on young bodies and young minds. Let these great prizes once exist in the education market, and we must expect that boys and young men will train for them, regardless of higher and more important considerations; that parents and teachers will allow themselves to join in the emulation—a few, perhaps, of their number mentally protesting, while looking on with "somber acquiescence."

By the side of the physical evils, at which we have glanced, stand equally serious evils of an intellectual and moral kind:

1. It should be noted that under the prize-system all education tends to be of the same type, since boys from all schools of the same grade meet in the same competition, and all teaching tends to be directed toward the winning of the same prizes. No more unfortunate tendency could be imagined. The health and progress of every great science, such as education, depend upon continual difference, upon new ideas, and experiments carried out to give effect to such ideas; upon the never-ending struggle between many different forms and methods, each to excel the other. It can not be too often repeated that uniformity means arrest of growth and consequent decay; diversity means life, growth, and adaptation without limit.

2. We hold that the preponderating influence of examinations destroys the best teaching. Under it the teacher loses his own intelligent self-direction. He can not devote his powers to such parts of a subject as are most real to himself, and most deeply felt by himself (though on this depend the impressiveness of all teaching and the awakening of permanent interest in those taught), as he is constantly controlled by the sense of the coming examination, in which of course he wishes his pupils to succeed. The pupil, on the other hand, allows himself to be mechanically guided

for the sake of success. His mental sympathies become bounded by the narrowest horizon. "What will pay" in the examination becomes his ruling thought, and he turns away from the many new intellectual interests, which would spring up on all sides of one who was allowed to be in love with knowledge for its own sake, as from luxuries that must be sternly put aside for the sake of success in the all-important examination. To a young and healthy mind the constant suggestiveness that accompanies work done in every branch of knowledge, the constant opening up of new interests, are the great stimulants to self-development, and they should be ever spurring the student on to endeavor to know more and to see more clearly. We hold that these life-giving interests can not possibly coexist with the repressing influences of training for great examinations.

3. The true value of different kinds of education can not be so intelligently considered and so easily measured by the public when these great prizes are in existence. It is most undesirable that important controversies, whether between classical and scientific education, or between the various methods of teaching, should be obscured by the serious monetary considerations that now throw their shadow over all educational work.

We do not propose to discuss here other more subtle evils, which appear to many of us to result from doing work simply for the sake of an all-important examination, such as the temporary strengthening of the rote-faculties to the neglect of the rational faculties, the rapid forgetfulness of knowledge acquired, the cultivation of a quick superficiality and power of cleverly skimming a subject, the consequent incapacity for undertaking original work, the desire to appear to know rather than to know, the forming of judgment on great matters where judgment should come later, the conventional treatment of a subject and loss of spontaneity, the dependence upon highly skilled guidance, the belief in artifices and formulated answers, the beating out of small quantities of gold-leaf to cover great expanses, the diffusion of energies over many subjects for the sake of marks, and the mental disinclination that supervenes to undertake work which is not of a directly remunerative character, after the excitement and strain of the race; nor will we discuss another class of evils, that falls less directly on the student, such as the waste of very precious time inflicted on the teacher by the drudge-work of examinations. It is enough now to affirm that the moral effect of the system, viewed broadly, is distinctly bad. We have made of our education a body without a soul. Our misdirected efforts result in a system which is *corruptio optimi*. There is no nobler influence that can be brought to bear upon a young student than the desire to get knowledge for the sake of understanding the world in which he has to live, the marvelous forces among which he has to act, the humanity of which he forms part, and thus of preparing a life of mental activity and happiness for himself, and of enlightened usefulness to others; but this influence is almost entirely set aside by the prize system. Only too often the greater part of the knowledge acquired for an examination, and the life which the student has presently to lead, are to him as matters separated by a great gulf, almost without connection with each other. We can not help asking why we should thus throw away the noblest and most enduring inducements that we possess, and put in their place motives which, except for the desperate effort of the moment, must be poor and unfruitful. We can find no good grounds for believing that the simple love of knowledge for its own sake, which at different periods of the world has acted so powerfully upon young and ardent minds, has in itself lost any of the old sacred fire; nor can we for a moment admit that the boys and young men of higher aspirations, who would be ready to follow Knowledge in a high and worthy spirit, should be sacrificed by an ignobly conceived system to the inferior-minded—if there are such—who can only be tempted to follow her because she means a sum of money, the public triumph of a successful class, or the gaining of a place. For those who can only be induced to work for such motives, let their friends provide in some special fashion such rewards and stimulants as they may find necessary; but for the higher type of boys and young men (and we believe they will gradually prove to be far the larger number, when we have once shaken ourselves free from the corrupting influences of the present system) let the effort be to offer the only true kind of teaching—the teaching of those who are in love with their subjects, and would, if allowed, devote themselves to calling out the same feeling in their pupils. At the present moment both teacher and pupil are morally depressed and incapacitated by a system that deliberately sets itself to appeal to the lower side of human nature. Again and again brilliant young men, once full of early promise, go down from the universities as the great prize-winners, and do little or nothing in the after-years. They have lived their mental life before they are five-and-twenty. The victory of life has seemed to them gained, and knowledge exhausted, almost before the threshold of either has been crossed.

It can not be too often insisted on that examination is a good educational servant, but a bad master. It is a useful instrument in the hand of a teacher to test his own work, and to know how far his pupils have followed and profited by his teaching. But it necessarily exerts a fatal influence whenever it is made of such importance that teachers simply conform to an external standard, lose faith in themselves, sink into the position of their own text-books, and give but little of their own personality to their work. It is true that it is necessary to test the work of teachers; but it is not necessary, for the purpose of doing so, to take the whole soul out of teaching. If examinations are to be defended on the ground that they test the efficiency of teachers, then we reply that other and better ways of doing this are to be found, and must be found. We admit quite frankly that they can only be found and pursued at the price of some trouble and experiment on the part both of parents and those responsible for the conduct of teaching; but if trouble and thought and experiment are to be spared in this great matter, we had better at once resign the hope of attaining any moral and intellectual results of real value from what we are doing. It has been suggested that masters and tutors might be induced to publish regularly notes of some of their courses; it has been suggested that some of the periodical examinations of boys and young men by their own masters and professors should be printed—with the questions and answers made—and sold in some cheap form; that parents and others interested should be invited to attend *viva voce* examinations. It is urged that such publicity would help to enlighten those specially interested as to the teaching given at different schools and colleges; and act as a moderate and healthy stimulus both to teachers and taught, without in any way producing the evil effects of the present fiercely competitive prize-system. We can not here attempt to express any opinion upon such proposals; but every reasonable plan for giving parents some acquaintance with what their sons are learning, and the methods pursued, deserve careful consideration.

In conclusion, we protest against the waste that accompanies the mischievous exaggeration of our present systems of examination. We protest against the great endowments of schools and universities being applied as money rewards for learning, either in the form of scholarships or fellowships, when they might be applied to increasing teaching-power, attracting men of high and varied learning as teachers to the universities, endowing concurrent chairs so as to admit the expression of different schools of thought on the same subjects, lowering to a certain point the fees taken for attendance, carrying the teaching of the universities into many different parts of the country, and assisting education in many other direct and useful ways. We protest against the common mistake of benefactors—anxious to help education—founding new scholarships, and thus intensifying the evil that exists, instead of founding local chairs and local courses of teaching; we renew our protest against the low ideals placed before young men; against the highly artificial competition to which both parents and teachers give their adhesion, and which destroys the real natural competition of method competing against method and type against type; and we protest against the assigning of Government positions by competition—a system which sets an evil example throughout the country and which does not insure the choice of the most fit. That the Government should require a high class of knowledge and attainment from those seeking for its appointments is reasonable; but the difficulties which attend the selection of candidates should not be allowed to bring upon us in wholesale fashion (though indirectly) the great evils which result from competitive examinations. It is urged—and the whole matter deserves serious consideration—that it would be better that some system should be sought out under which, for example, those who wished to enter the civil service, and who reached a certain standard of excellence required by the commissioners, should be practically tested in such way and for such period as could be conveniently arranged; that the most fitting should then be selected on public grounds by the permanent heads of departments. It is urged that some such a course—and others are to be suggested—should be preferred to the excessive and hurtful stimulus of special training for the one purpose of defeating in a great educational contest other candidates, also specially trained for the same purpose, and to the consequent encouragement of competitive examination throughout the whole country by the force of Government example. Here also we desire to express no opinion of any kind upon the suggestion given, but simply to point out how important it is that those who are most qualified should turn their attention to this subject with the view of discovering the best way of avoiding both the evils that belonged to the past and those that belong to the present.

We have only to add that what we have said as regards the education of young men and boys necessarily applies with increased force to young women and girls. It is deeply to be regretted that their education is becoming simply a stale repetition of the mistakes made in the case of men. In their instance it is to be expected that the injuries to health and bodily vigor will be even greater; while the delicate perceptive powers, which they possess in larger measure than men, are likely to suffer irreparable injury. We can only hope that with the abolition of the class and prize system there will grow up a much more delicate appreciation than exists at present of the subtle influences, both for good and for evil, of education; and that the easy credulity with which this generation has placed "book learning" before a careful training of the senses and higher faculties may slowly give way to truer views.

We ought to add that we sign this paper in general agreement with the principles expressed in it, and not as individually expressing entire adhesion to all details.—*Nineteenth Century.*

SKETCH OF MOSES ASHLEY CURTIS.

THE Rev. Moses Ashley Curtis, D. D., presents the example of a clergyman who, doing hard pioneer missionary work in the mountains of North Carolina, and caring actively and efficiently for the wants of his parish, brought the botany of his State to a full development. Making that study his pastime and recreation, "he found pleasure in the quiet of the fields and forests, and, without ever a thought of becoming a scientific botanist, amassed a wealth of knowledge and won an exalted position among the botanists of the world." His services to science have, nevertheless, been unaccountably overlooked. Although he was in constant co-operation with the most distinguished specialist in the world on fungi, although he contributed more than any other man to the knowledge of the botany of North Carolina, and particularly of its mountain-region, and was continually consulted and relied upon for information by Dr. Gray and other American botanists, his name does not appear in any cyclopædia or publicly circulated work. Our data for the present account of his career are derived from a sketch of his botanical work prepared by Dr. Thomas F. Wood, of Wilmington, N. C., and read by him before the Elisha Mitchell Scientific Society of the University of North Carolina, in 1885.

Dr. Curtis was born in Stockbridge, Mass., May 11, 1808, and died in Hillsborough, N. C., in 1872. He was graduated from Williams College in 1827, and in 1830 became a tutor in the family of Governor Dudley, at Wilmington, N. C. He returned to Massachusetts in 1833, and spent two years in studying for the ministry, under the Rev. William Croswell. He returned to the South in the latter part of 1834, was married in December of that year, and, having continued his theological studies under the Rev. Dr. R. B. Drane, was ordained a clergyman in the Protestant Episcopal Church in 1835. He immediately entered upon mission-work in western North Carolina, from Charlotte to the mountain country as far north as Morganton. Leaving this work at the end of 1836, he was engaged as a teacher in the Episcopal school at Raleigh during 1837 and 1838 and till May, 1839. During 1840 he performed missionary work about Washington, in Beaufort County; then, in 1841, became settled in Hillsborough for six years; removed, in 1847, to Society Hill, S. C., where he resided for nine years; and returned, in 1856, to Hillsborough, which was his home for the remainder of his life.

The first mention of Mr. Curtis's field studies in botany is associated with his residence and tutorship in Wilmington, where he devoted his leisure hours to the examination of the flora of the region. Especially on Saturdays he made excursions among the sand-hills and savannas near the village (it was then), close up to whose borders the pine-forests reached, "abounding with a flora rich and novel to the enthusiastic young botanist." In a little more than two seasons he made collections of 1,031 species, equivalent to about one fourth of the phenogamous flora of the United States as then known; most of the plants having been found within about two miles' radius of Wilmington, with a number of maritime species discovered at Smithville and several from Rocky Point. The results of these studies were given to the public as an "Enumeration of Plants growing spontaneously around Wilmington, North Carolina, with Remarks on some New Obscure Species," which appeared in the "Boston Journal of Natural History," September, 3, 1834. Most of the first edition of the publication was burned; but it was reprinted, with additions and emendations. Dr. Gray mentions this work as one of the first in America in which the names are accented; and Dr. Darlington commended Mr. Curtis, even at this beginning of his scientific career, as a careful observer and sagacious botanist. At this time the literature of American botany consisted chiefly of florulas or local floras, of which the best known were those of New York, by Dr. Samuel L. Mitchel and Major John le Conte; Boston, by Dr. Jacob Bigelow; Washington, by Dr. J. A. Brereton; and Lexington, Ky., by Prof. C. W. Short. In North Carolina, Prof. Elisha Mitchell and the Rev. Dr. L. De Schweinitz had been studying the plants; Mr. H. B. Croom and Dr. H. Loomis printed a catalogue of plants found growing in the neighborhood of Newbern, at nearly the same time that Mr. Curtis's work saw the light; Dr. James F. McCree, Sr., was cultivating botany at Wilmington, and, the two having learned to co-operate with each other, added several species to the catalogue, thirty-four in notes and a number in the catalogue proper; Dr. Cyrus L. Hunter had prepared a list of plants found in Lincoln County; while the Rev. Dr. Bachman, Mr. H. W. Ravenel, and Mr. Leitner were looking after the plants near their homes in South Carolina and Georgia.

"If there is such a thing as a scientific instinct," says Dr. Wood, "Mr. Curtis possessed it. He was habitually accurate in his studies, and the results were early relied upon by his correspondents. Coming into a new field of botanical study, it was quite natural that he should have directed his attention to the very local *Dionæa muscipula*. Saturday after Saturday he would visit the savannas, and, lying at length upon the ground, would watch its peculiarities. The popular description which he gave of it in the 'Enumeration of Plants around Wilmington' has been repeated for the last fifty years, and shows how greatly he possessed the gift of accurate and entertaining description." Dr.

Gray says that in this note he "corrected the account of its wonderful action that had prevailed since the time of Linnæus, and confirmed the statement and inferences of the first scientific describer, Ellis—namely, that this plant not only captures insects, but consumes them, enveloping them in a mucilaginous fluid which appears to act as a solvent." The journeys which he had to make in pursuing his mission-work in the mountainous region were turned to the advantage of his botanical studies. He kept a portfolio under the cushion of his sulky, ready to receive any specimen which he might find; so that, when he reached the end of his journey, he had collected a considerable number of specimens to study during his leisure hours, or to mount permanently in his herbarium. Dr. Gray acknowledged himself greatly indebted to him for local information concerning the flora of this region, and said, in a paper in which he sketched the tours of the botanists who had visited the mountains of North Carolina in 1841, that no living botanist was so well acquainted with the vegetation of the Southern Alleghany Mountains, or had explored that of the State so extensively, as he. A half-century after the publication of the Wilmington catalogue, only about fifty species had been added to Mr. Curtis's list. One of these was the true maiden-hair fern (*Adiantum capillus-Veneris*), which was found by Mr. William M. Canby, of Wilmington, Del., in 1867, at Hilton Ferry. Specimens were immediately sent to Mr. Curtis, and he improved the first opportunity to visit the locality and see the plant *in situ* for himself.

Dr. Curtis's labors on the fungi began at least as early as 1846, when he became engaged in a correspondence with Mr. H. W. Ravenel, of South Carolina, a large collector in this department. About two years after this he entered into correspondence with the Rev. M. J. Berkeley, of England, concerning which we learn that that very distinguished authority on this subject became greatly attached to him "by reason of the ardor and accuracy with which he pursued the investigation of new species. . . . Correspondence between these gentlemen continued for a number of years, and a scientific copartnership was formed which resulted in the addition of nearly five hundred new species (besides more than twelve hundred identified by De Schweinitz, chiefly in North Carolina) to the list up to 1867; and since Dr. Curtis's death a number of new species appeared in 'Grevillea,' under the joint authorship of Berkeley and Curtis." This new field of study was greatly to Dr. Curtis's liking, and he became very skillful in the microscopic work necessary to the determination of species. He became too devoted to it, perhaps, for his health was undermined in consequence of the close attention he gave to it. It was a genuine case of pure love of the work; for the stimuli and temptations to labor for distinction which exist now were wanting in his day; and thus he was led, almost unconsciously, to a very high station among American botanists. Concerning this, he remarked to Dr. Wood: "Nothing surprised me more than to be called a botanist at first. Although I had accomplished the survey of the phenogamous plants of the State, I still felt that I was comparatively not a botanist." Several years later than this—about 1855—he began to give special attention to the edible mushrooms. He finally became a kind of missionary and propagandist of mushroom-eating. In the catalogue of the plants of North Carolina he had indicated one hundred and eleven species of edible fungi known to inhabit the State; and he had no doubt that there were forty or fifty more, in the less explored Alpine regions. He was accustomed to distribute basketfuls of the choicest specimens among his friends, "until the divine art of mycophagy reached a good degree of cultivation, and many of them learned to distinguish for themselves the edible ones. Some members of his family became especially expert in foraging for the table among the mushrooms"; and his son used the knowledge thus acquired in preparing the colored illustrations for the contemplated work on "Edible Fungi." This book was projected during the civil war, when the food-question was a vital one in Southern households, and was intended to make popular the use of mushrooms. In it, Dr. Wood affirms, the author succeeded in divesting himself of every technicality, and indeed in describing minutely about forty of the one hundred and eleven species in language easy to be understood, and in an enticing manner. Illustrations and comparisons were occasionally drawn from foreign authors. The work failed to find a publisher.

Dr. Curtis's studies of plants embraced every feature and relation that he was able to bring under observation. "Just to name a flower and preserve it carefully in his herbarium," says Dr. Wood, "was to him but the beginning of his work. His earliest records show that he studied the relation of plant-life to geologic and climatic surroundings. The study of botanical geography was begun and continued during his whole career as a botanist, extending over thirty-eight years. The account he has given us in his 'Woody Plants' is to-day the best guide to the natural climatological divisions of the State which has ever been given. His studies were also directed to the numerous economic questions which met him in his intimate acquaintance with the treasures of the field and forest. It was this feature of his labors alone which brought him an audience in his adopted State, and with this object in view he brought together the material which he published as a part of the Geological and Natural History Survey, known best by the condensed title given to it by Prof. Emmons as the 'Woody Plants.' This volume, of one hundred and twenty-four pages, was printed by the State in 1860, and at once became a popular manual for the farmer and the woodsman, and for amateur botanists a key to the more conspicuous trees and shrubs useful for their fruit or timber or as ornaments. The key devised to enable one of no botanical knowledge to determine a given plant or shrub was founded upon the character of the fruit and distinguished by the common name. The preface of this little work is an introduction to the geographical distribution of plants in the State, and shows what a thorough acquaintance he had with the vast subject." The essay made prominent the exceptional position which North Carolina holds in respect to climate, soil, and forest products, by calling attention to the existence of a difference in elevation between the eastern and western parts, which gives a difference of climate equivalent to ten or twelve degrees of latitude. The work displays an accurate knowledge of common names, with all the local changes which they undergo. It has been liberally drawn from by subsequent writers, not always with due acknowledgment. In "A Commentary on the Natural History of Dr. Hawks's 'History of North Carolina,'" published in the "University Magazine" in 1860, Dr. Curtis corrected many errors into which the author had fallen by accepting the exaggerated and too highly colored accounts of the old travelers and explorers concerning the plant-growth of the State.

Dr. Curtis's "Catalogue of the Indigenous and Naturalized Plants" of North Carolina was published by the State in 1867 as a part of the Geological and Natural History Survey. At the time of its issue the author asserted that, comprising forty-eight hundred species, it was the most extensive local list of plants ever published in North America. It is claimed to have been the first attempt to enumerate the cryptogamous as well as the phenogamous plants ever made by any botanist in this country. It consisted of one hundred and fifty-eight pages of catalogue, with no scientific description, but a mere statement of the locality of each plant, and was the result of twenty-five years of botanical study over a territory of fifty thousand square miles. Pathological mycology had only begun to be studied in Dr. Curtis's lifetime. An incident related by Dr. Wood suggests that, had he engaged in this branch of investigation, he might have become a master of the subject. A group of doctors were examining some figures of microscopic fungi in Beale's "Microscope in Practical Medicine," and particularly the *Oïdium albicans*, which was supposed to be a cause of thrush. Dr. Curtis coming in, at once recognized a very familiar fungus, and, showing that the spores could only find lodgment when the soil was prepared to receive them, cautioned his friends against forming too hasty conclusions as to the disease-carrying properties of the fungi. Instead of being the cause of disease, they were as likely to be its result.

Dr. Curtis had an extensive correspondence with American and European botanists, who always recognized the part he took in the progress of the science in this country as important. Dr. Chapman dedicated the first edition of his "Flora of the Southern States" to him. The "American Journal of Science" in 1873, after his death, thus measured his work: "All our associate's work was marked by ability and conscientiousness. With a just appreciation both of the needs of science and of what he could best do under the circumstances, when he had exhausted the fields in phenogamous botany within his reach, he entered upon the inexhaustible ground of mycology, which had been neglected in this country since the time of Schweinitz. In this difficult department he investigated and published a large number of new species, as well as determined the old ones, and amassed an ample collection, the preservation of which is most important, comprising, as it does, the specimens, drawings, and original notes which are to authenticate his work. By his unremitting and well-directed labors, filling the intervals of honored and faithful professional life, he has richly earned the gratitude of the present and ensuing generations of botanists."

The bibliography of Dr. Curtis's writings includes "Enumeration of Plants growing spontaneously around Wilmington, N. C." (1834), twice reprinted with additions and emendations; "New and Rare Plants of North Carolina" (1842); "Contributions to Mycology of North America" (1848); "New and Rare Plants, chiefly of the Carolinas" (1849); "Contributions to Mycology of North America" (Berkeley and Curtis, 1849); "New Fungi collected by the Wilkes Exploring Expedition" (1851); "Geological and Natural History Survey of North Carolina; Part III, Botany, containing a Catalogue of the Plants of the State, with Description and History of the Trees, Shrubs, and Woody Vines" (1860); "A Commentary on the Natural History of Dr. Hawks's 'History of North Carolina'" (1860); "Esculent Fungi" (1866); "Geological and Natural History of North Carolina; Part III, Indigenous and Naturalized Plants" (1867); "Edible Fungi of North Carolina" (1839). The first of these works was published in the Boston "Journal of Natural History," and the last in the "Gardener's Chronicle," London. The others were published either in "Silliman's Journal" or as separate publications.

CORRESPONDENCE.

A CORRECTION.

Editor Popular Science Monthly:

MR. McGEE, in his article on "Paleolithic Man in America," in the November issue, falls into an unfortunate error in stating that I had found twenty-five thousand specimens of true paleolithic implements *in the gravel*. The number found is about four hundred, and this represents twelve years of most laborious search for them. Happily, it is enough to establish the fact that paleolithic man existed at the time so graphically described in McGee's article.

The error is explained, I am sure, by the author having in mind the number of catalogued specimens of the Abbott collection at the Peabody Museum at Cambridge, Mass. This collection is not of glacial man only, but of his immediate successor—the Eskimo?—and of the Delaware Indians.

CHARLES C. ABBOTT.

TRENTON, N. J., *November* 27, 1888.

RELATION OF ALTRUISM TO EGOISM.

Editor Popular Science Monthly:

SIR: Having read, with interest, Mr. Smiley's article on "Altruism" in your November number, I venture to point out what seem, in my view, to be his errors and mistaken reasonings:

At the outset, while ignoring the fact that an intelligent and reasonable self-sacrifice lies at the very basis of the Christian system, he virtually confounds it with the extreme self-abnegation of Buddhism. There is a fundamental difference between the two. The latter system involves the utter renunciation of individuality by an absorption in Nirvana. This is the total annihilation of personal identity, the abnegation of all selfhood. For this end Buddhism demands painful and extreme penance and the denial to all good. It aims primarily, for others, at the removal of this life's lower evils, its physical woes and material necessities, and for its devotee it works mainly, if not chiefly, toward his own personal deliverance from such ills, toward a virtual non-existence.

The Christian system is just the reverse of this. Pre-eminently it recognizes and maintains the individuality of every man, disintegrating him from the great mass of humanity, and making him, separately and personally, accountable to a great Creator and a Supreme Judge. While aiming, subordinately, at the counteraction of this life's lesser evils, it strikes at the greater and gigantic forms of moral ill, lifting humanity up to a higher spiritual plane of blessedness. Thus, by means of self-discipline and wise sacrifice, it promotes human good, recognizing all men as of one great brotherhood.

Mr. Smiley then takes isolated passages of the Bible, out of their proper connection, unmodified and unbalanced by others, thus giving to them a one-sided and pessimistic meaning. Particularly does he misapprehend the intent of Christ in his command to "take no thought for the morrow," making it to enjoin, as he says, "an utter disregard of self" and a putting away of provident foresight, such as characterizes every thoughtless beggar and lazy tramp!

Now, every tyro in Greek knows that the word (μεριμνήσητε) translated "take no thought" does not refer merely to mental action, but rather to emotional concern, that which is accompanied by pain and trouble, so that Christ only interdicts that overweening anxiety and distressing thoughtfulness which many indulge, and which not only is opposed to a simple faith in divine providence, but emasculates the heart and unfits one for effort even toward his own good. Thus the Teacher virtually enjoins a rightful egoism.

Paul did not construe Christ's command as does Mr. Smiley, for he enjoined a proper foresight in saying that "if any provide not for his own" (the Greek being τῶν ἰδίων), for his own private, personal, and particular interests, "and especially for those of his own house, he hath denied the faith and is worse than an infidel." What stronger egoistic teaching than this could any one wish? This self-providence Paul implies in his command to the Roman Christians that they should be "not slothful in business," which is in accord with Solomon's precept, "Go to the ant, thou sluggard." Thus, Mr. Smiley has not had regard to the comparative teachings of the Bible, as well as to the true signification of its original terms.

He affirms further that Christ's declaration of a simple fact, that "the poor we have always with us," was very "*unfortunately*" said. Now, not even assuming any divine quality for Christ, but simply admitting him to be a man of profound wisdom and far-seeing philosophy, how could his statement, contrary thereto, have been *unfortunate?* Mr. Smiley, however, puts this phrase about the ever-presence of the poor as approving and commending their condition, while indeed it simply states an inevitable and incontrovertible fact, growing more and more so, in each successive age, not because Christian self-denial and altruistic charity have produced this result, but because increasing and crowding populations and social vices, especially in the world's great cities, with multiplied luxuries, present temptations to self-indulgence and idleness, ultimating in poverty.

If, as Mr. Smiley asserts, the benevolent methods of relieving the poor have not diminished their number, it is evidently due not to such altruism but to these antagonistic causes. Can he prove that such benevolence has *not* legitimately tended, in any measure whatever, toward the checking of such evils as lead to poverty, and to the forestalling of such corruptions as ruined the republics of Greece and Rome as well as other great nationalities? Just here Mr. Smiley does not recognize the clear logical distinction between a mere occasion and an efficient cause—between an incidental result and a legitimate effect. Pro-slavery men, both at the North and the South, failed to make this distinction when they declared that the anti-slavery men brought on the rebellion, and that therefore they were the culpable cause of it. No! Slavery itself was the cause—the abolitionist was only the occasion. The one worked for evil, the other for good: if evil came through the latter, it was but incidental, not legitimate. Every system, however excellent in itself—not being perfect, of necessity—implies or involves occasional ills. Is Mr. Smiley logical in making the incidental results of altruism, as evil, its necessary and legitimate effects? Is it a causal force to human ills? Granting, indeed, that some among the poor have abused gifts and become idlers, has this been the universal fact? Has charity always made beggars and tramps, or are such only sporadic and exceptional cases, while, to a large extent, social benefits and industrial results have come from individual and organized benevolences? Does not Mr. Smiley reason illogically and with a pessimistic spirit, taking only a few isolated and unfavorable facts and the worse aspects of the case from which to draw a general deduction?

While, indeed, his argument rightly prevails against a heedless and indiscriminate benevolence, it does not appertain to careful and systematic giving. All properly organized institutions and all thoughtful schemes of benefit to the poor take into consideration and aim at the improved industrial condition and moral advancement of their beneficiaries. Such organizations are designed and formed to operate for the very end of rendering beggary dishonorable and unprofitable, and for inspiring the poor with industrial self-respect. They say to the charitable man, "Do not give promiscuously, but through the medium of those agencies which have regard to the elevation as well as the relief of the poor."

If, as Mr. Smiley assumes, the improvidence and demoralization of the poor are the legitimate effects of charity working as an efficient cause, then, of course, it is a curse. But this is not the case. Rather the primary causes are the ignorance, the illiteracy, the prodigality, and the lack of moral training among the poor, as well as bad legislation and tempting surroundings. To charge all this upon a self-denying charity is logically wide of the mark.

The first argument which Mr. Smiley offers against orphan asylums is that "moral corruption, brought in a little by each child, leavens the whole lump." Here he assumes that each child necessarily brings in more or less corruption, and therefore he presumes that no orphan has any inherent purity, which is a virtual admission of a native depravity such as he would, perhaps, be far from positively asserting. As a general rule, children are received into orphan asylums before they are old enough to carry corruption into them. If this argument of Mr. Smiley has any real force, it must equally prevail against all schools, private or public, against families and neighborhoods in which children of different ranks and characters come into close personal contact with each other, and are more or less good or evil. Would Mr. Smiley isolate these children and segregate such communities? Does he not know that in all these orphan asylums moral and Christian teaching is often more clear, pronounced, and effective for the good of the child than may be found in many a school or household? Is it not most likely that, where one or two children may prove corrupt, the moral tone of the many, under right training, would tend to counteract and correct the evil of the few?

In his second argument against these asylums Mr. Smiley assumes that only incompetent teachers are employed in them, and, as if in proof of this, he asks, "Who ever knew a scholar reared in an orphan asylum?" Well! who ever heard of one reared in a State-prison, a factory, or a coal-mine? Who ever expected orphan asylums to turn out scholars? Was this the design of their establishment? But, in answer to this charge of Mr. Smiley, it may be truthfully said that not all, and indeed very few teachers in such institutions are incompetent. They stand, generally, on a par with those of our public schools, some of them being men and women of education and refinement, who, from pure love of children and their moral good, devote themselves, in some cases gratuitously, to such benevolent work. Mr. Smiley can scarcely have studied the histories and statistics of orphan asylums, or he would not have charged upon them bad food, poor training, and rejection from good families, in respect to all which it may be shown unquestionably that he is sadly mistaken. Neither would he have ignored the fact that the children of drunken fathers and mothers are not usually taken into *orphan* asylums, or, if they ever are, then they are saved from the horror and ruin of a drunkard's home, in which every true philanthropist should rejoice.

As to "foundling asylums," Mr. Smiley is still more severe, asserting that every one "in America should be instantly disorganized"! On what ground? Because, he says, "they encourage crime"! But does the vile man or frail girl, committing evil, pause beforehand to deliberate how the possible fruit of the crime is to be taken care of? No! any such consequence is not thought of; if it were, that would be a restraint upon immoral tendencies. But Mr. Smiley can be shown some "foundling asylums" where poor but virtuous women have found homes for their true children, when they have not been able to provide for these, or have been out at labor in families and factories, especially when their husbands have been sick, feeble, or vicious, and therefore could not provide for their legitimate children. Would Mr. Smiley deny to such women so great a privilege?

As to the encouragement of immoral girls, I can point Mr. Smiley to one "foundling asylum," at least, in Chicago, originated by Dr. George Shipman, a homœopathic physician, who assured me that only about one in a hundred women, coming with their babes, could be regarded as essentially criminal. They were either unfortunate wives or deceived girls, who, having received at the asylum proper instruction, were taken into respectable families as domestics. Rarely did one such fall, especially as the restraint was put upon them tnat a second lapse would forbid their return. Would Mr. Smiley disorganize such an institution? Would he break up Mr. Müller's great establishment in Bristol, or that of Dr. Cullis in Boston, wherein many have been housed, fed, comforted, and rightly trained, fitted for death or for usefulness in life, and from which so many rescued victims of poverty and distress have gone forth into the world to find success and honor?

If Mr. Smiley had consulted the records of education societies, he would have found, what any one of its secretaries, I know, would have told him, that scores and even hundreds of thorough female teachers and distinguished pulpit orators have been the happy and successful beneficiaries of such societies. Their statistics plainly show this. The one sporadic case to which he refers is an individual and marked exception to the general rule and does not justify a broad deduction as to the evil of those organizations. "One swallow does not make a summer," neither does one snow-flake make a winter.

In pressing "egoism" to the exclusion of "altruism," or to its disparagement, Mr. Smiley would feed that natural selfishness which is common, more or less, to all men, and which, unrestrained, tends to such extremes as bring vast misery to mankind. He thus antagonizes that law of love which is the rhythmic force in the moral world. A great Teacher said, "Thou shalt love thy neighbor as thyself"—no more, no less. He here brings altruism into juxtaposition with egoism. They are counterparts and correlatives, each essential to the other. As in the solar system the centripetal and centrifugal forces keep its orbs apart and in space with equilibrium, so these two forces of egoism and altruism balance each other, and promote the harmony of society. As in physical science both the positive and negative poles of the battery are needed for the generation of magnetism or electricity, so these two moral poles must be coincidently present and work together to the production of moral magnetism for human benefit. As in logic, induction and deduction, according to Sir William Hamilton, are not antagonisms, but, if not identical, are certainly counterparts, the one reciprocally leading to and involving the other—so are egoism and altruism; they are associative and co-operative. Common love binds them together; common interests, as with all human associations, bring them into unity of thought and action for the greatest mutual good. Once, Wendell Phillips, speaking of capital and labor, said, "They are twins—Siamese twins—bound together by a living ligament, to cut which would be to kill both." They are interdependent, vitally united. So with egoism and altruism. They need each other for true existence and right action. Egoism alone runs to selfism; altruism alone to fanaticism. Together, they are mutually compensative—apart, destructive. Of the two in union, the words of Shakespeare's Portia may be predicated: "It blesseth him that gives and him that takes." That union fulfills Christ's words: "Give and it shall be given unto you, good measure, pressed down and shaken together and running over, shall men give into your bosom. For, with the same measure that ye mete withal, it shall be measured to you again." In these words, egoism and altruism are pronounced correlative and compensative. Does not the patriot feel rewarded fully when dying for his country? Does not the martyr, though suffering physically, rejoice thus to maintain truth? Does not the benefactor, like a Slater or a Hand, giving his millions for the education of an ignorant and despised race, feel assured of due return? If the arguments of Mr. Smiley were carried out practically to their ultimate and logical results, then all such patriots, martyrs, and benefactors must be relegated to the realms of folly or forgetfulness. Then the egoistic Alexanders and Napoleons must have exaltations above all Howards, Wilberforces, Garrisons, and Caroline Frys.

May it not be suggested that Mr. Smiley has taken rather a one-sided, prejudiced, and pessimistic view of his subject? Has he not failed to take note of abundant and palpable facts controverting his positions? What if the altruism he condemns be banished from society? What then would the world do without the multitude of noble, self-sacrificing men and women whose love of humanity has led them into the deep, dark slums of our great cities for the rescue of the perishing; who have suffered themselves to be socially ostracized by teaching the black children of the South; who have dared the Mormon monster in his den, to extirpate the curse of polygamy; who have dwelt in Indian wigwams to civilize the savage; who, for medical science or society, have breathed the infections of small-pox or yellow fever; or who, like Livingstone and Stanley, have penetrated the wildernesses of Africa for the suppression of the slave-trade? Shall it be said to all such: "Renounce your altruism and rest in your egoism; self-sacrifice is not wisdom, beneficence is not profit"? Shall it be said to all founders of hospitals, as well as asylums, of colleges like Harvard, Yale, Cornell, and Johns Hopkins, with their scholarships, "Ye are the monuments of altruistic error"? Shall it be said to benevolent and moneyed men, who can not personally work for humanity: "Hoard your money; waste it not on charities"? Is their benevolence to be smothered by the smoke of eleemosynary institutions which the egoistic torch would consume?

Truthfully yours,
C. H. A. Bulkley.
Howard University, Washington, D. C.

THE WORK OF THE BURROWING RAT.

Editor Popular Science Monthly:

In your November number there appears an article, by Prof. N. S. Shaler, entitled "Habits of the Great Southern Tortoise," which is based upon premises so manifestly erroneous that it is difficult to understand how the professor could have been led to adopt them; and, therefore, in the interest of science, I take the liberty of pointing out to him, through you, the error which he has made. Having lived in Florida for several years, and having during that time closely observed the habits of the land-tortoise, or so-called "gopher," to which the professor refers, I know whereof I speak. The professor is entirely mistaken in supposing that the little mounds of sand which he describes are made or pushed up by the *tortoise*, or "*gopher*." They are the result of the industry of quite a different animal, viz., a species of *burrowing, pouched rat*, known in eastern Florida as the "salamander."

The land-tortoise, or gopher, *never* burrows into the earth beyond a distance of *ten* or *fifteen feet*, where he goes merely for concealment, not for food. He never obstructs the outlet of his burrow, but keeps it open, so that he may readily return to the surface of the soil to seek grass and other vegetable matter, upon which alone he subsists. It is true that he hibernates during the winter months. I have caught hundreds of "gophers," and have shot or caught in traps dozens of the "salamanders," and I am prepared to substantiate what I have here stated in the most indubitable manner. It is manifestly a physical impossibility for the *tortoise* to burrow its way thousands of feet horizontally under the ground, as the professor supposes.

I can easily imagine the amusement which Prof. Shaler's article would afford residents of Florida, should it reach their eye. Such inexcusable errors in scientific papers are not calculated to bring honor to science or to the scientist.

Very respectfully,
C. C. Byrne, M. D.
Washington, D. C., *November* 1, 1888.

[In a former paper, referred to at the beginning of the article on the "Southern Tortoise," Prof. Shaler mentioned the disturbance of the soil due to burrowing rodents. The second article was devoted wholly to the work of the tortoise, but does not seem to us to conflict with the statement that other animals produce effects of this sort in Florida, even exceeding in some localities those produced by the tortoise.—Editor.]

A DOG THAT COULD COUNT.

Editor Popular Science Monthly:

On page 123 of your November number Dr. A. S. Hudson relates incidents to show that animals may be able to count. In 1868 an Omaha printer, named Bolster, owned a terrier bitch that could count. On being told by her owner to climb a certain number of steps and lie down, she obeyed, never making a mistake, although the task given was varied so as to test her ability. She gave evidence of equal intelligence in other directions, and there is no doubt that she could actually count up to fifteen.

Yours, etc., J. D. Calhoun.
Omaha, *October* 24, 1888.

THE TYPE-WRITER FOR THE BLIND.

Editor Popular Science Monthly:

In an interesting article on "Writing-Machines for the Blind," published in "The Popular Science Monthly" for September, I was surprised to see no mention made of the type-writer as having been utilized for that purpose; and, as the author seemed thoroughly acquainted with his subject, he would doubtless have noticed the fact had it ever been used.

From the readiness with which the blind learn to manipulate the keys of the piano, it is to be presumed they would have no difficulty in managing those of the type-writer—a process which could be still further facilitated for them by having the letters on the keys raised. The printing type could be beset with sharp points, so as to prick out the letters on the sheet instead of printing them with ink, and, by using paper of the proper thickness, a distinct raised lettering would thus be made, which the blind could decipher by feeling.

It is true, the printing would be reversed, but in spite of this the type-writer for the blind would have advantages which, it seems to me, no other instrument of the kind yet invented possesses.

E. F. Andrews.

Macon, Ga., *November* 1, 1888.

[Ordinary type-writers are used by hundreds of blind operators for writing to seeing persons. A blind person, having once learned the arrangement of the keys, has little difficulty in operating the instrument. This is one of the uses proposed for it by the inventor of the earliest form of type-writer, Charles Thurber, in 1843, and one of his machines is now in existence which had originally raised letters on the keys to facilitate such use. In order that the printing shall be legible to the blind, of course some mode of pricking or embossing the paper would have to be employed, and the reversing of the print, to which our correspondent alludes, could easily be obviated by reversing the type.—Editor.]

THE EXTENSION OF THE SUFFRAGE TO WOMEN.

Editor Popular Science Monthly:

In Prof. Cope's "Relation of the Sexes to Government," in the October number of the "Monthly," he makes intellectual inferiority, physical inability, and the social position of woman the practical objections to granting her the "privilege" of suffrage, and favors its restriction rather than an extension.

But even if men are on the whole superior to women, the difference is not so great but that, if the same restrictive process were applied to women and men, a considerable minority of the women would fulfill the conditions which a not very large majority of the men could fulfill. Although any system of suffrage can only be an approximation to what might be best, it is a poor approximation indeed that will shut out a large minority of one sex because the majority of that sex fail to fulfill the qualifications for suffrage. That is majority-rule with a vengeance.

It is declared that "woman suffrage becomes government by women alone on every occasion where a measure is carried by the aid of woman's votes." Then government by a successful party, whose candidate is elected by a majority of one thousand in a "deciding State," becomes government by five hundred and one men; and government everywhere becomes government by the smallest possible majority of the majority by which a party elects its candidate. What becomes of popular government? It is further declared that, if women vote with their husbands, suffrage becomes a farce. It is a very plain social fact that men who associate much come to think alike, especially on subjects that are much thought upon. Like teacher, like student; like father, like son. Politics runs in families almost as much as features do. If all who acquire their political leanings from their constant associates shall not vote, a very large majority of the sons of the country must be disfranchised, and in a generation there will be no voters at all. And if the women of the land, by exercising suffrage, run the danger of becoming the mothers of a "generation of moral barbarians," are the fathers of the race so entirely different in quality from the mothers that the transmission of a very large amount of barbarism might not be prevented by a wholesale restriction of the suffrage?

Physical inability to execute the laws when they are made, and to defend them in a military capacity, is made a principal objection to the granting of suffrage to women. "This consideration alone, it appears to me, puts the propriety of female suffrage out of the question." But only a small proportion of men are willing to be executors of the law, as policemen and sheriffs; and, as for the judicial positions, an even smaller proportion is *fitted* to fill them. Restriction of the suffrage would be a good thing; let it be applied under the principle of immunity from military service, and who would be disfranchised? War demands able-bodied men; only men that are perfectly regular in form and sound in health can be soldiers. If immunity from service is to form the boundary-line of suffrage, all the rest, a vast number, would be shut out. This excluded list would include perhaps the best class of voters the nation has—the older men—because they are exempt from military duty. But I am sure the professor himself would be unwilling to begin restriction under the principle he has enunciated, and reduce the elders of the nation to the condition of Gulliver's Luggnaggian *struldbrugs*.

Frank Cramer.

Appleton, Wis., *October* 10, 1888.

EDITOR'S TABLE.

THE MARCH OF PRACTICAL SCIENCE.

It is idle to be continually repeating that this is a very wonderful age; but we may with good reason congratulate ourselves that science has now reached a point that insures to the human race an ever-increasing mastery over the powers and resources of nature, and that ought, with any kind of right management, to be productive of better modes of life from year to year, not for the few only but for all. At the last meeting of the British Association an address was delivered by Mr. Preece, President of the Section of Mechanical Science, which, though confined to the single subject of the recent advances in the practical applications of electricity, furnishes a vivid picture of the changes which scientific knowledge generally is working in the world. Things that to our forefathers were perfect types of the unknowable, are to-day, as Mr. Preece remarks, among the best-understood of natural phenomena, if not in relation to their ultimate cause, at least in regard to the laws of their operation. Among the various troublesome questions asked of the patriarch Job was one as to whether he could send lightnings, so that they might come and go at his bidding. Of course, Job had to give it up; but that was not because the problem was absolutely insoluble, but because he had not the scientific knowledge necessary to solve it. To-day lightnings are flying to and fro in most complete subjection to the will of man; and even the free lightnings of heaven have to a large extent been placed under bonds to do him no harm. Mr. Preece antedates, we observe, by five years the classical experiment of Franklin with the electricity of the clouds, placing it in 1747 instead of in 1752; but he is correct in stating that nearly a century elapsed after Franklin's great discovery before, as a working power, electricity was fairly mastered. Naturally the Church was opposed to the study of electricity in its beginnings; but that study has been too fruitful of beneficial results, and too victoriously successful all along the line, to remain under a ban of any kind. Churches themselves are now protected by lightning-rods against random thunderbolts, just as the clergy, in common with other classes, are protected by vaccination against small-pox. On the subject of lightning-rods, Mr. Preece's declaration that "as long as points remain points, as long as conductors remain conductors, as long as the rods make proper connection with the earth, lightning protectors will protect," is a word spoken in season; as also is the caution he goes on to give as to the neglect of the conditions upon which the whole efficiency of the system of protection against lightning depends.

It would be impossible within our limits to give anything like a satisfactory summary of the very interesting address to which we have referred. Two or three points may, however, be singled out for notice. The electric telegraph may now be said to have been in use for business purposes for half a century. The rate of transmission at the outset was five words a minute; to-day it is six hundred. Cooke and Wheatstone required five wires for their first needle instrument, which worked only at the rate of four words a minute; whereas one wire now conveys six messages simultaneously at ten times the speed. On the 8th of April, 1886, now nearly three years ago, when Mr. Gladstone introduced his Home-Rule Bill in the British House of Commons, no less than 1,500,000 words were sent over the wires from the Central Telegraph office in London. Mr. Preece seems to approve of the purchase of the telegraphs by the British Government. He states that the telegraph business which, when assumed by the Government in 1870, brought in £550,000 per annum, now yields £2,000,000 per annum; and that the annual number of messages has increased from 6,000,000 to 52,000,000. What the increase in revenue and work done would have been had the telegraphs remained in private hands, it is impossible to say. Government telegraphing is cheap—6*d*. for a message to any part of the United Kingdom—and that, no doubt, tends to make it popular. Mr. Preece refers with natural pride to the leading part Great Britain has taken in the laying of submarine cables. British ships, he states, have laid 110,000 miles of cable; and British capital to the amount of £40,000,000 has been expended in this very useful work. The railway system of to-day could not have reached its present development without the aid of the telegraph, by means of which the whole movement of trains is checked and controlled from moment to moment. A well-equipped signal-box on a main line of railway is a very interesting place to visit. To quote the words of the address: "The signal-man is able to survey the lines all round him by the aid of his electric signals; he can talk by telegraph or telephone to his neighbors and his station-master; he learns of the motion of the trains he is marshaling by the different sounds of electric bells; he controls his out-door signals by the deflection of needles or the movement of miniature semaphores; he learns the true working of his distant signals by their electric repetition; machinery governs and locks every motion that he makes, so that he can not make a mistake." The safety thus secured for the traveling public is indicated by the fact that in the whole United Kingdom the average annual loss of life by railway accidents in the five years ending 1887 was only sixteen, or, as Mr. Preece computes it, one life to every 35,000,000 journeys made by train.

Great inventions have often a considerable period of incubation before they assume their proper importance and development. Thus, nearly seventy years elapsed between the discovery of the electric light by Sir Humphry Davy and its practical introduction for purposes of street-lighting. Mr. Preece is enthusiastic for the electric light, which he contrasts in its purity and wholesomeness with "filthy gas and stinking oil." He states that in the Central Savings-Bank, at London, the introduction of the electric light was followed by an appreciable improvement in the health of the staff. Every year sees some increase of efficiency or diminution of cost in connection with this admirable system of lighting. At this moment it is beyond comparison the cheapest method of producing any given unit of light. For the working of tram-cars or street-railways, Mr. Preece is of opinion that electricity is incontestably the agency destined to be most extensively used in the near future. In saying this he has in view the climatic conditions of the British Isles; but there is good reason to expect that experiments now being made in this country will demonstrate that, even where snow-storms have to be contended with, electricity will carry the day in the contest with horse-flesh. The progress made in the electrolytic extraction of metals from their ores is shown in the fact that whereas not long ago it was considered economical to absorb 0·85 horse-power in depositing one pound of copper per hour, the same work can now be done with 0·3 horse-power. The uses, however, of electricity are almost beyond enumeration. We have electric welding, electric production of chlorine, iodine, and oxygen, electric decomposition of poisonous gases, electric fire-alarms and frost-alarms, electric photography, electric bells, electric clocks, electricity as a curative agent, and electricity as a substitute for hanging. The question as to what electricity is, or how it may be most correctly defined, will probably continue to furnish matter for debate for some time to come. Mr. Preece finds fault with those physicists who object to recognize in electricity a form of energy, and insists that the engineer has a right to speak of electricity as he finds it, and therefore to speak of it as "energy." This is a dispute into which we can not enter further than to say that the arguments urged by Mr. Preece do not seem to us to touch the position of the physicists. We are with him entirely, however, when he says that "the engineer feels that steam and electricity in his hands have done more to economize labor, to cheapen living, to increase wealth, to promote international friendship, to alleviate suffering, to ward off war, to encourage peace, than all the legislation and all the verbosity of the politician." It is satisfactory to think that, while science is being railed at in certain quarters, its methods are being ever more fruitful of good to mankind. Science is doing its part nobly in the world, and, if moral results do not seem to keep pace with the enlightenment of the age, that should be a matter of special concern to those who feel themselves responsible for the moral interests of the community. May it not be reasonably said that, if they would do their work as well as the man of science is doing his, an equal success would crown their labors? It is all doubtless a matter of the adjustment of means to end; and, when the right means are employed in the moral sphere, we may expect to see there a progress not less marked than that which is now taking place in theoretical and practical science.

THE ABUSE OF EXAMINATIONS.

No more timely or important document has been given to the world, of late years, than the protest reprinted in our present number from the "Nineteenth Century," on the subject of the sacrifice of education to examinations. The protest in question is signed by the leading educators of Great Britain, and by many others eminent in science and letters. It is re-enforced by separate articles by England's greatest philologist, Prof. Max Müller; her greatest historian, Prof. Freeman; and her most brilliant and philosophical essayist, Mr. Frederic Harrison. All these men see clearly that a great intellectual and moral injury is being done to the nation by an excessive use of examinations, and, generally, by an excessive stimulation of the work of education. The universities do their own share of mischief by offering large pecuniary prizes as the rewards of proficiency tested by examinations. The Government helps on the evil cause by making access to the public service a simple question of "marks." Teachers obtain their positions and schools their grants in the same way; while the unfortunate pupils are having their studies continually interrupted in order that some one may grub at the roots of their growing knowledge for the purpose of spying out how weak a thing it is, and, in doing so, making it still weaker.

The philosophy of the whole business is simple enough. So long as the intellectual development of a country is following a simple, unforced course, education will be pursued for the sake of the essential benefits it brings; and educators will think chiefly, if not exclusively, of the true intellectual interests of their pupils. There will not be a feverish anxiety to ascertain the precise results achieved at a score of different points in a course of instruction. It will rather be taken for granted that only those who desire to profit will seek instruction, and that the result of their studies will appear in some spontaneous form in later days. If questions are asked, it will be for the sake of exciting intellectual interest, or of giving an opportunity for diversities of treatment of a certain topic. It will not be done in the spirit of the highwayman who offers you the alternative of surrendering your money or your life. But when once a "great public interest" has been awakened in education, and the Government has "taken it up in earnest," and grants of money become available for schools that can earn them by passing a certain number of pupils through certain grades, then the whole spirit of education becomes changed. The student's one ambition—if he has any at all—is to pass an examination, the teacher's is to get as many of his pupils as possible to pass as many examinations as possible; and to these wretched ends the whole work of the school is made subservient. There is no time allowed for reflection or for the slow gathering of results, none for the enjoyment of what is learned, none for the gathering of wayside illustrations; all is hurry and press, strain and stress, business from the start and business to the close. The result is, the all but complete extinction of true intellectual interests. Our young people do not learn to love knowledge for its own sake, for any sense of mental enlargement that it confers, or for any benefit that it enables them to bestow on their fellows. They hardly have time, indeed, to realize the difference between what is real and vital in knowledge and what is its mere outward husk or shell; and they leave school in thousands with intelligences blunted rather than sharpened, and—we grieve still more to think—with moral sensibilities dulled rather than quickened, by the routine to which they have been subjected.

Some may hold that we overdraw the picture; but there can hardly be a doubt in the mind of any liberally cultivated man or woman that the evil to which we refer, and on which the signers of the "protest" that has given rise to our remarks expatiate, is a very real one. We trust sincerely that the whole subject will receive a very thorough discussion, and that, in our own country, there will prove to be a sufficient force of enlightened public opinion to introduce at least some partial reforms. More than this, in an essentially state-directed system of education, we dare not hope for.

Our readers who have followed the "New Chapters in the Warfare of Science," by Dr. Andrew D. White, as they have appeared from time to time in the "Monthly," will be glad to learn that the publication of this unique series will be resumed in the February number. These papers are characterized by novelty, pith, and scholarly research. Dr. White has devoted several years to the investigation of his subject, and is now in Europe, examining the libraries and collections of antiquities for additional material. This research, which the author is making unusually exhaustive, can not fail to bring out many facts and incidents in the history of dogma and superstition which have never before seen the light, or have been buried in obscurity for centuries. With such resources at his command, Dr. White is in a position to lay before his readers some very remarkable illustrations of the persistent dominance of delusion in the human mind. But much more than this superficial interest is aimed at, for the author hopes by the publication of these papers to start some trains of thought among reflecting men which shall be of permanent service alike to Christianity and to science. The chapters immediately forthcoming will treat of the subject of "Demoniac Possessions and Insanity."

LITERARY NOTICES.

English Composition and Rhetoric. Part II. Emotional Qualities of Style. By Alexander Bain. New York: D. Appleton & Co. Pp. 325. Price, $1.40.

The discussion of the subject of this volume is considerably amplified from that given in the original work, with a more precise classification and fuller detail of examples. The subject is confessed to be beset with peculiar difficulties, arising from the vague and indefinable character of the human feelings, which can not be described directly or accurately analyzed; it can be approached only by the way of wide comparison and illustration. The first step taken by the author is to classify the emotions common to poetry and the fine arts; and in this we find at the outset that the lines are hazy and discernible only by the aid of acquired faculties. Next to be studied are the aids to emotional qualities, the common end of which is the evoking of emotions of the pleasurable kind. The conditions of treatment under which they are brought into effect are representative force, concreteness and objectivity, personification, harmony, ideality, novelty and variety, plot, and refinement. The qualities themselves are designated as strength or sublimity, beauty, feeling or pathos, humor, wit, and melody; of which melody and feeling are perhaps the least ambiguous, while most of the others are liable to complications that make scientific precision in the language of criticism very difficult. Under the first head are brought the contrasted emotions of love, tender feeling, and sociability, on the one hand, and irascibility, malevolence, and antipathy on the other. It may seem paradoxical to enumerate the emotions of the latter category among the promotives of pleasure, but an analysis of the best literary works will show that these darker aspects of feeling are as essential as the shadows in a picture. Feeling includes the varieties of love, friendship, patriotism, compassion, religion, personified feeling, and sorrow or pathos; humor, the group of qualities centering in the ludicrous. When place is given to all these qualities, there still remains a region of effects not fully accounted for—beauty; the sense qualities; utility, which can hardly be divorced from the special emotions, but stands to a certain degree remote from any one interest; and imitation, which lends itself to further the special qualities, but has also an independent charm. Next to the minute and methodical treatment of the emotional qualities, the chief peculiarity of the present work is the line-by-line method of examining passages with a view to assigning merits and defects. These passages occupy a considerable proportion of the space, and are representative, both of the rhetorical qualities which they illustrate, and of the classical authors of all times, including the best-known contemporary authors of the literary nations. This feature, while completing the value of the book for study, makes it also attractive for leisurely reading.

Realistic Idealism in Philosophy itself. By Nathaniel Holmes. Boston and New York: Houghton, Mifflin & Co. In Two Volumes. Pp. 521 and 499. Price, $5.

Starting with the presumption that man aspires after and must have some theory of himself, of the universe in which he lives, and of life, duty, and destiny in it, the author disposes of all the ancient theories—intuitional systems, he calls them—as vague and not competent to stand the test of a truly philosophical criticism. But the stream of thought and light that poured through antiquity, gathering strength from the various ethnic sources by which it was fed, was transmuted "into the learning and wisdom of the Christian era, such as they have been." Exactly how much the knowledge or culture of the present time has been indebted to either of the ancient systems, or how much to those of the Christian centuries alone, it would be difficult and perhaps unimportant to specify. "The one most certain thing of all is that the knowledge of nature, the insight into any true theory of this universe, or into any true wisdom in the conduct of life in this world, or into any assurance of life hereafter, that has been gained within the last five hundred years, is of more worth and value to mankind than all the rest put together." The modern speculations of philosophical theists are declared to have been too much biased by preconceived notions concerning biblical revelation, by influences growing out of reverence for Christian beliefs and popular opinion, or by subjection to an established church, to be of the value that they should be. The class of writers of which Voltaire may be taken as a representative—being mainly literary and iconoclastic—have failed to present a statement of universal philosophy or a conception of the Deity that need detain much the critical thinker of this century. Scientific methods deal with facts as facts, and are not directly concerned about a theory of God or the universe. "Physical science is a kind of external ladder by which the human mind endeavors to ascend, step by step, to the topmost height (as it were) of all knowledge. The higher it mounts, the more certain it is to find itself entering into the still higher realm of the internal and metaphysical, ending only in the universal and absolute." A metaphysical system is likewise insufficient without the verification of its conclusions by a thorough science of external nature. If philosophy has hitherto failed to furnish a satisfactory theory, the greater is the need that it should still endeavor to accomplish it. A condition is that "it must be able to take up all science, all nature, all humanity, into clear solution, leaving nothing out, or nothing but nothing." Of the four theories of the universe that stand before the world for consideration, the biblical-supernatural theory leaves philosophy to become impossible and impertinent; the materialistic-machine theory has no room for anything but physical science; and in the mystical-idealistic theory—which supposes that we have no certain knowledge of external nature, but only of the ideas or images which are formed in our minds on sensation and sense-perception—the business of philosophy is to make it as intelligible, credible, and acceptable as possible. The realistic-ideal theory, or realistic idealism, which gives the name to the book, holds that the real and the ideal are not two distinct worlds, but only the two sides or aspects of one and the same whole actuality of real essence and power. "Its method is both analytical and synthetical, is neither exclusively dialectical and deductive, nor wholly experimental and inductive, but is both at once; it is, in short, the universal method of the metaphysical logic which takes up all science into intelligible and clear solution." It is the purpose of the work to unfold, explain, and establish this theory. The book is a hard one to read, but the difficulty lies in the nature of the subject, and the fullness of the author's thought, requiring corresponding fullness in expression, and not in any defect of the workmanship. The author has studied the subject, and has mastery of his thought and knowledge of what he wishes to say.

The Tenth and Twelfth Books of the Institutes of Quintilian. With Explanatory Notes. By Henry S. Frieze. New edition, revised and improved. New York: D. Appleton & Co. Pp. 294. Price, $1.40.

The value of Quintilian in classical study consists in the opportunity which his work furnishes for at once getting knowledge which has a direct bearing on professional life, and for attaining a higher scholarship in the Latin language. The *Institutio Oratoria*, or "Education of the Orator," is an invaluable contribution both to polite literature and to liberal education, and capable of being made practically useful to young men in their preliminary training for public life. The tenth and twelfth books are selected for the purposes of the present text because of the interest and importance of the topics discussed in them: the former book relating to the practical studies and exercises that contribute to the formation of a good style, and the twelfth presenting a kind of outline of what the character and life of an orator should be. Prof. Frieze's work in this preparation is based most largely on the labors of Prof. Bonnell and those German scholars who have given most attention to Quintilian. The present new edition has been revised in view of the later labors of Carl Halm and G. T. A. Krüger; and the notes have been amplified, with the view to making them helpful wherever help may seem to be needed.

Antiquities of the State of Ohio. By Henry A. Shepherd. Cincinnati: John C. Yorston & Co. Pp. 139.

This monograph is a portion of the author's "Popular History of the State of Ohio." It deals with the ancient inclosures, mounds, *caches*, tombs, etc., located in that State, and the objects found within them. In Ohio alone there have been till recently not less than ten thousand mounds and from fifteen hundred to two thousand inclosures. In other parts of the Mississippi Valley they are so numerous that no attempt has ever been made to count them all. The inclosures are usually regular in outline, and vary in size from an acre or less to three hundred and fifty or four hundred acres. Most of them appear to have been designed for religious purposes, while others were apparently places of defense. The mounds have been classified as sacrificial mounds, mounds of sepulture, temple-mounds, and anomalous mounds. To these may be added the effigy-mounds, of which there are only three or four in Ohio, the most remarkable of them being the "Great Serpent" mound. In his descriptions of these works and the objects found in them the author quotes frequently from Squier and Davis, and from later explorers recognized as authorities on this subject. Plans, diagrams, and views illustrate the text.

Hygiene of the Nursery. By Louis Starr, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 212. Price, $1.50.

The object and spirit of this book can not be better expressed than in the following extract from its preface:

> Having a firm belief in the proverb that "an ounce of prevention is worth a pound of cure," the author has endeavored, in the succeeding pages, to point out a series of hygienic rules which, if applied to the nursling, can hardly fail to maintain good health, give vigor to the frame, and so lessen susceptibility to disease. He feels, too, that intelligent parents are ever ready to be instructed and willing to co-operate in the great work of preventing disease—the highest aim of scientific medicine. While every woman of ordinary brain-power can do much to keep her baby well, she should recognize that years of training and experience are necessary to acquire the ability to put the full value upon symptoms, and to handle the tools of medicine. Therefore, little or no reference has been made to drugs or methods of medical treatment.

The first chapter, describing the normal appearances of the infant in health, is written with the object of hinting to the mother when by deviations from such conditions she may be apprised of the onset of disease, and call in professional counsel. The last chapter, on emergencies, is offered as a guide in cases where immediate action will save much pain and danger. Besides ordinary accidents and disorders, those which occur only at birth or soon after are treated of, and directions for making various poultices and plasters are given. The other chapters tell how to manage everything that affects the every-day life of the infant. The choice and furnishing of a room for the nursery, the selection of a nurse-maid, the infant's clothing, exercise, and amusements, sleep, bathing, and feeding, are all treated with full details. The subject of food occupies the most space, and recipes for preparing quite a variety of foods are given. Throughout the volume the directions are clear, simple, and complete, and the expectant mother who possesses this book, with a fair share of common sense, is well equipped for the care of her baby.

The Virtues and their Reasons. By Austin Bierbower. Chicago: George Sherwood & Co. Pp. 294. Price, $1.35.

This book is designed both as a treatise for the general reader and as a text-book of ethics for schools. In arrangement, it follows a classification of duties which divides them first into duties regarding others chiefly, and those regarding self chiefly. The five subdivisions of the former class are: kindness, truth, honesty, family duties, and public duties. Duties to self comprise self-development, industry, self-support, self-control, temperance, self-respect, purity, and conscientiousness. "Moral instruction is often excluded from the public schools," says the author, "on account of the different religions represented, and the want of text-books acceptable to them all." Hence he has purposely adopted such a method of treatment that "Catholics, Protestants, Jews, and unbelievers may use this book with equal approval." He does not go into the question what constitutes right; "it is enough now to observe," he says, "that, whatever men's opinions touching the ground of right, they all deem those things right which are thought best for men, and consider that course morality which will bring them most happiness." Accordingly, the matter under each head throughout the book may be described as a statement of those things which are thought best for men. The volume is without an index.

The Advance-Guard of Western Civilization. By James R. Gilmore (Edmund Kirke). New York: D. Appleton & Co. Pp. 343. Price, $1.50.

This volume has a close relation with the two previous historical works by the same author—"The Rear-Guard of the Revolution" and "John Sevier as a Commonwealth-Builder," the three together presenting, as is remarked, a phase of American history to which sufficient prominence has not been given—the story of the foundation and growth of the Tennessee commonwealth. The title of the first volume is justified in the fact that, but for the enterprise and courage of the hardy pioneers who broke their way into the woods of the Southwest and formed settlements there, the rear of the American colonies during the Revolution would have been exposed to Indian attacks in the interest of Great Britain, while such attacks were relied upon as a part of the scheme of subjugation. The present volume relates to the emigration of James Robertson as leader of a party of three hundred and eighty men, women, and children from the Watauga foundation to the Cumberland River, the settlement of Nashville, "the first civilized settlement in the valley of the Mississippi," and the subsequent fortunes of that post and the neighboring stations, down to the conclusion of peace, through Robertson's efforts, between the Creeks and Chickasaws, in 1795. Robertson lived till 1814, and had the privilege of giving eminent services to the Government, by holding the Choctaws and Chickasaws to their allegiance against Tecumseh's efforts to engage them in his conspiracy; and of him the author claims that, judging by the standard of fidelity to duty and devotion to the good of men, there have been few greater characters in American history.

Hand-Book of Historical and Geographical Phthisiography, with Special Reference to the Distribution of Consumption in the United States. Compiled and arranged by George A. Evans, M. D., New York: D. Appleton & Co. Pp. 295. Price, $2.

In this volume the author has attempted to present a sketch of the development of our knowledge of pulmonary consumption from the time of Hippocrates to the present day, together with the ascertained facts respecting the geographical distribution of the affection. The historical portion, which is mostly a translation from Waldenburg's work, gives the results of the several studies that have been made of the subject, from the days of the "father of medicine" down, with summaries of observations and theories in the order and under the names of their authors; closing with the present aspect of the question as represented by Koch, and the views of other contemporary authors. In the chapters on geographical distribution, the data for countries other than the United States are compiled from Hirsch; and those for the United States from the reports of the census. In discussing the question of "locality in relation to deaths" in the United States, the country is divided into twenty-one "regions," each of which has its peculiar features of climate, soil, topography, prevailing diseases, and death-rate. The general statistics of the United States and the principal cities, in respect to mortality by consumption and other diseases, and the topography and climate, and death-rate, by counties, from consumption, are given separately. The etiology of consumption is next taken up; and the conclusion is expressed, in the last chapter that the antiseptic treatment—natural, by living at high altitude, which is only negatively antiseptic; or artificial, by breathing medicated air—is the best.

Botany for Academies and Colleges. By Annie Chambers Ketchum, A. M. Philadelphia: J. B. Lippincott Company. Pp. 324, with 250 Illustrations.

This is not a very large book, but it epitomizes the whole science of botany, with a copious inventory of botanical material. While the statements are extremely concise, they are intelligible, and well exhibit the connections and relations of facts. Following the inductive method of Jussieu, the author unfolds the development and describes the structure of plants, from the cryptogamia—"the green stain on our door-stone"—to the highest orders, the magnolia and the clematis, taking each stage in the order of its evolution. "Thus, at the outset, we see the principles upon which differentiation is based." The proof of the theory and the authority for the order followed are indicated in a special lesson on fossils, and this is accompanied by a geological table showing the successive periods of organic and inorganic development in which the predominances of the orders of animals and plants are exhibited side by side. Then, with the plant world thus outlined, the physiology of the subject is taken up, and the separate parts are studied—root, stem, leaf, flower, fruit, tissues, and the forces that govern them. A single deviation from the method of Jussieu — the one usually followed by systematic botanists—is made in the case of the gymnosperms, which are separated from the dicotyledons and made a distinct class, coming immediately after the cryptogams. "In nature," the author says, "we find gymnosperms associated with the higher cryptogams in the order of development; they form *comprehensive types*, including the characters of cryptogams, monocotyledons, and dicotyledons—they are not true dicotyledons"; and she believes that if Jussieu had known what has been discovered since his time, he would have favored the change. The "Manual of Plants," forming the second part of the volume (some 200 pages), contains lists of all the known orders with their representative genera—a very desirable feature, for few of our manuals give them so exhaustively—with tables of abbreviations and etymons, or roots of botanical terms and names of plants.

Soaps and Candles. Edited by James Cameron. Philadelphia: P. Blakiston, Son & Co. Pp. 306. Price, $2.25.

Like the other technical hand-books in the same series, this volume consists of the articles in Cooley's "Cyclopædia" on the subjects to which it is devoted, with added information from various sources. The user of the book is assumed to have some knowledge of general and analytical chemistry, hence details of many chemical processes are omitted. In the chapters devoted to soaps, the materials employed are enumerated, and the preliminary treatment of raw fatty substances is described. Lye-testing by the hydrometer and the chemistry of saponification are touched upon, and the apparatus and arrangement of the factory are then set forth. Processes are given for manufacturing a large number of household, toilet, medicinal, red-oil, soft, and industrial soaps, also a dozen methods of recovering glycerin from spent lyes. A chapter on testing soaps closes this part of the volume. In the same manner the manufacture of candles is described. The volume is illustrated with fifty-four cuts of apparatus.

Not only new but novel is *Quick Cooking* (Putnam, $1), which its author calls "a book of culinary heresies." Its chief departure from the established culinary creed is in asserting that "there is no waste in the kitchen so much to be deplored as wasted time." Many of the recipes in the common run of cook-books are extremely complicated, and few women have the faintest realization of the extravagant amount of time they consume in proportion to the results achieved. They have been made in the most random fashion by adding one substance and manipulation after another, according to the fancy of the maker, and then slavishly followed, without any intelligent effort to find a simpler process for attaining an equivalent result. "Quick Cooking" claims to furnish, in five, ten, or twenty minutes, dishes as delicate and appetizing as those elaborate affairs which one must potter over from twice to ten times as long. This book contains six hundred and thirty recipes, three hundred and forty of which "can, severally or in groups, be made ready for the table in from five to fifteen minutes, and two hundred and fifty of which require from fifteen to forty minutes, or, rarely, an hour's time." A "Black List" of thirty-nine favorite recipes is appended, so called because the most strenuous efforts have not succeeded in materially reducing the time which these dishes require. Each of the three divisions is arranged alphabetically. The whole range of dishes, from soups to sweetmeats, is represented. Prefixed to the recipes are some practical suggestions of a general character, and a table of weights and measures.

"Comfort on $150 a year" is an idea that will provoke from many an incredulous smile, but that this idea can be realized by intelligent management is demonstrated in *How she did it*, by *Mary Cruger* (Appleton, 50 cents). In pleasant story form is told how Faith Arden, with a few hundred dollars and borrowing $700 more on mortgage, buys an acre of rocky hill-side, erects a cottage upon it, which she supplies with furniture from her former home, and some articles constructed by herself, with the aid of a handy carpenter, and then begins housekeeping alone. She has an income of $300 a year, and at the end of six months finds that her living expenses, when there are no extra outlays, need not exceed $150 a year, leaving an equal sum for interest, taxes, and the reduction of her mortgage. This gives her a varied fare and many comforts. A former school-friend, with two children old enough to be helpful, then joins her, contributing at the rate of $350 a year to the expenses of the household, and the next quarter's account shows a balance of $63, which is increased to $139 for six months. The story is not a visionary one. The author states that it is "an actual portrayal, step by step, of her own experience, her own wonderful success in carrying out a long-cherished theory of comfortable economy. The every-day life described is not a poetically imagined affair, but one that she has absolutely lived and gloried in."

A second edition of the *Chemical Lecture Notes* of Prof. *C. O. Curtman* has been issued, and now includes notes on the metals. The volume is edited and published by Prof. H. M. Whelpley (St. Louis, $1.50), who has extended some of the lecturer's memoranda, and supplied a hundred cuts. Most of the cuts are in the division of chemical physics, which occupies about one third of the book. The chemistry proper is a course in general chemistry, and, although arranged for students in pharmacy and medicine, is quite full, more so than is generally given to these classes of students. Prof. Curtman's notes on organic chemistry are not included in this volume.

Mr. *W. H. P. Phyfe*, author of "How should I pronounce?" has now issued *The School Pronouncer*, based on Webster's unabridged dictionary (Putnam, $1.25). Mastering the 366 pages of this little text-book implies an amount of phonetic drill which should give the pupil a better command of English pronunciation than the average person generally has. The book is divided into three parts, in the first of which the sounds of the English language and the diacritical marks used to represent them are set forth, and extended exercises are given on the two hundred and thirty symbols, consisting of one or more letters, by which these sounds are represented in English spelling; also on the various ways, ranging from two to eighteen, of representing each one of the simple sounds. The lessons in this part are in catechetic form. The author enumerates forty-two sounds in the language, but the distinctions which he makes between *e* in *ermine* and *u* in *urge*, and between *o* in *odd* and *o* in *dog*, will be regarded by many as useless refinements. The second part comprises drills on the elementary sounds, and seventy-seven graded lists of twenty words each for phonetic analysis. Part third consists of twenty-four hundred words often mispronounced, arranged alphabetically, each word, both here and in part second, being respelled phonetically. Many names of persons and places are included in this list. Two appendixes treat of diacritics met with in other books, and eight sounds found in French and German words, but not in English. The volume is printed with large and clear type throughout, and there is no crowding of matter on its pages.

H. C. G. Brandt's First Book in German (Alleyn & Bacon, Boston, $1) is a selection from the same author's "Grammar," containing Part I, or the accidence and syntax, with new indexes, and Lodeman's exercises and the complete English vocabulary. These portions of the larger work have been put together for use in secondary schools, in place of some of the short grammars. The distinguishing feature of the part of the grammar here presented is the complete separation of inflection and syntax. The exercises for translating into German, by Prof. A. Lodeman, are intended for the double purpose of furnishing material for translation and of assisting in the analysis and translation of the more difficult illustrations in the "Grammar." They are framed upon the theory that examples from the German classics are the proper kind of illustrations for a text-book of this order.

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POPULAR MISCELLANY.

Fast Ocean Passages.—It was about fifty years ago, with the introduction of iron ships and the screw-propeller, that the era of rapid steamboat traveling began. The paddle-wheel steamer Great Western sailed from Bristol, England, April 8, 1838, and reached New York April 23d. This was welcomed as a great achievement, for the passage across the Atlantic had been made in half the time fermerly required. Two years later the Cunard steamers began to sail, the pioneer vessel being the Unicorn, a little craft, which made the passage from Liverpool to Boston, *via* Halifax, in sixteen days. Improvements in the new method of navigation were made in rapid succession. In 1845 the Great Britain—the original ocean screw-steamer—left Liverpool July 26th and arrived at New York August 10th. In May, 1851, the Pacific crossed the Atlantic in nine days, nineteen hours, and twenty-five minutes. The usual time for the passage was still ten or eleven days in 1859. It is only within the last ten years that the speed of ocean-steamers has become phenomenal and their size enormous. The strictly modern class of steamships may be said to have begun with the Arizona, built in 1879, which made the Atlantic passage in the fastest time then on record, attaining a speed of twenty and one third statute miles an hour. In the same year was launched the Alaska, which in 1882 was the first vessel to cross the ocean in seven days, gaining thereby the title of "greyhound of the Atlantic"; but still fleeter "ocean greyhounds" soon appeared. The Oregon outstripped the Alaska, running at the rate of twenty-two miles an hour, and in 1884 was herself eclipsed by the Umbria, making twenty-three and a half miles an hour. Then came the City of Rome, which made the eastward passage in six days, twenty-two hours, and twenty-five minutes; and in February, 1887, the Etruria came to the front with a record of six days and nineteen hours from Liverpool to New York. The Umbria and the Etruria have made several reductions on this time, and the present best record is held by the Etruria, which made the passage from Queenstown to New York in September, 1888, in six days, one hour, and fifty minutes; but we may expect a still further reduction by either of these ships on her next trip. Nearly equal speed has been made between England and Australia. At the beginning of the century this passage required eight months by sailing-vessels, and is now made by steamers in about six weeks. The Ormuz, launched in 1887, was designed to greatly reduce this time, and, although at first not realizing expectations, in October of the same year she exceeded them by covering the distance between London and Adelaide in a trifle under twenty-four days.

Colors of Flying-Squirrels.—A paper was read in the American Association, by Mr. W. E. Taylor, on color variations of Nebraska flying-squirrels. The American flying-squirrel presents a range of geographical variation in size quite unparalleled in other members of the *Sciuridæ*. On the other hand, the coloration is remarkably constant. The local variations in color were illustrated by descriptions and comparisons of five specimens examined by the writer, all collected near the Missouri River, in Nebraska, at different times and places. The writer concludes: 1. That the measurements correspond to the Northern variety, while the colors correspond more nearly with the Southern varieties. 2. Local variations in color are great, these variations existing in members of the same nest. 3. Locally, at least, the two varieties appear to grade into each other. 4. The degree of coloration on some parts of different specimens does not vary in the same rate.

Value of Experimental Psychology.—Pointing out the advantages of the experimental method of psychological investigation, combined with the introspective, Dr. J. McK. Cattell, of the University of Pennsylvania, says: "Experiment is not meant to take the place of introspection, but is meant to make scientific introspection possible. The study of consciousness is, as we all know, fraught with peculiar difficulties. It is not easy to be at once the observer and the observed. The eye sees not itself, and the phenomena are both complex and transient. The best results have been obtained when introspection has been combined with the study of the objective manifestations of the contents of other minds, more especially when these have on the one hand become fossilized, as in language, customs, art, etc., or, on the other hand, are relatively simple, as in children, in savages, and in disease; but, under circumstances the most favorable to scientific observation, there are serious difficulties in the way of exact observation and measurement, and it will be found in psychology, as elsewhere in science, that experiment gives the most trustworthy and accurate results. Experiment calls up the phenomena to be studied when wanted, and by keeping certain conditions constant and by altering others gives the best chance for analysis; above all, it enables us to photograph the transient phenomena and subject them to objective examination and measurement."

Continental Centers. — The orographic centers of the several continents have been graphically determined by M. A. de Tillo as follows:

CONTINENTS.	Latitude.	Longitude (from Greenwich).
Asia, with Europe	43° N.	85° E.
Africa	4° N.	127° E.
North America	45° N.	102° W.
South America	14° S.	56° W.

These four centers form a fairly regular quadrilateral. The longest side (92°) is the one between the Asiatic and North American centers. The African center is distant 82° from the South American center. It is worthy of remark that the distance between the centers of the double continents is approximately the same, the center of Asia being 70° from that of Africa, while the centers of the double American continent are separated by 73°. The geometric center of the four continents is in the region of the Azores and the Canaries.

The Energy in an Earthquake.—After explaining, in the American Association, the impossibility of calculating the intensity of an earthquake more than approximately, Prof. T. C. Mendenhall applied a formula to determine the energy involved in the Japanese earthquake of January 15, 1887, which disturbed over 30,000 square miles of territory. He said: "Assuming a mass of 150 pounds per cubic feet, and taking a cubic mile as the volume to be considered, I find that to put it in vibration required the expenditure of 2,500,000,000 pounds of energy. Assuming that an area of 100 miles square with a mean depth of one mile was thus in vibration at any one instant of time—which is not improbable, considering the known rate of transmission and the long duration of the earthquake—the amount of energy thus represented would be 25×10^{12} foot-pounds. This energy might be generated by the fall under the action of gravity of a cube of rock 1,000 feet on each edge, the mass of which would be 75,000,000 tons, through a vertical distance of 166 feet." Also, assuming certain magnitudes, "I find the energy of a cubic mile of the Charleston earthquake, taken near enough to the epicentrum to be disturbed as above assumed, to be equal to 24,000,000,000 foot-pounds. The speed of transmission of this disturbance has been pretty well determined by Newcomb and Sutton to be approximately three miles per second, so that a cubic mile would be distributed in one third of a second. To do this would require 130,000,000 horse-power. Assuming that an area about the epicentrum 100 miles square was thus disturbed, the energy would be that of 24×10^{13} foot-pounds, and the rate of its expenditure would be that of 1,300,000,000,000 horse-power."

Gems.—The diamond became generally employed as a finished gem in France during the first quarter of the fifteenth century. The art of cutting it has gradually improved and developed, until now, two million five hundred thousand carats of diamonds are annually cut in Amsterdam. The principal source of supply has shifted from India to Brazil, and now to South Africa, whose Cape diamonds at present furnish ninety-five per cent of European supply. The quality of these diamonds, according to Mr. Alfred Phillips, has been purposely underestimated by interested parties. It is true that colorless diamonds have been found in the smallest proportions in South Africa, but it is equally beyond dispute that large numbers of the whitest and most faultless diamonds are exported from the Cape, while the mass of the material is conspicuous, whether white or colored, for its brilliancy. The ruby is next highest in value, and after it comes the sapphire, which is only another colored ruby. Although the cheapest of the major gems, its loss, according to Mr. Phillips, would be, on account of its intrinsic value and unrivaled blue color, a greater misfortune to the art-goldsmith than that of either the ruby or the emerald. The emerald is one of the most beautiful, although the softest, of the precious gems, and is easily fusible with borax into a colorless glass. The true emerald occurs in crystals seldom over one inch in length. The so-called Oriental emerald of India is not an emerald, but a green ruby or sapphire. The exquisite tones peculiar to the minor gems, or those of lesser value, establish them as a separate category when compared with the magnificent or acknowledged gems. Among them the amethyst was worn in the middle ages as an amulet and preservative in battle, and was distinguished as a pious or episcopal gem, figuring wherever it was desirable to impart serious beauty or dignity to the property of the church. Then we have the chrysolites, the topazes of various hues, and the garnets, Oriental varieties of which ranked with gems of a higher order rather more than a century ago. The opal was held in the highest repute in ancient times, first for its beauty, and then because its own mythology constituted it a harbinger of love and good-will. It has lost in value in modern times, through the influence of a silly superstition. The selenite, or moonstone, is a gem of great beauty, and admits of a great variety of applications, on account of the softness of its tint, which enables colored gems, diamonds, and enamels to be agreeably associated with it.

About a Crocodile.—"Ubique" (Parker Gillmore) tells, in "Land and Water," of a crocodile which he saw in Java almost seventeen feet long. "It frequented the vicinity of a place where the village women were in the habit of assembling to wash their clothes, and, if report spoke truly, many were the Malay females it had carried off. At length it was captured by using a live dog for bait. After being transferred from its watery home to the commandant's garden, it was safely secured upon the lawn by innumerable moorings. Our assistant surgeon administered the saurian an immense dose of strychnine, enough, as he said, to poison a regiment, but it had not the slightest injurious effect upon the brute. Its skin, I believe, is still to be seen at the Dutch East Indian Museum at Amsterdam. If there is one animal more than another detested by the human race, it is the crocodile, and, if possible, the hunter or sportsman hates it more than all others combined, for it is certain to carry off his dogs sooner or later." The call of the crocodile is described as being like the snappish bark of an aggrieved dog.

Two Snake-Stories analyzed.—Two American snake-stories—one about a singing snake said to be in the Smithsonian Institution, and the other about a rattlesnake that was said to have poisoned itself—having been referred to Dr. Arthur Stradling for a verdict on their credibility, he has pronounced them both intrinsically false. No snake on earth, he says, has any vocal apparatus, properly so called, whatever, or is capable of producing any respiratory sound beyond a hiss or a wheeze. But they may in the last stage of canker give vent to a noise almost amounting to a squeal, caused by forcible expiration; and, if they happen to have swallowed a frog alive, he may croak audibly in the snake's stomach. To what extent a poisonous serpent's bite is noxious to itself is doubtful. "Probably it inflicts mechanical injury only upon its own body, or upon those of its immediate congeners. . . . I have seen cobras bite and shake each other like dogs over disputed rats, and I recollect a jaboia being heavily mauled by a puff-adder under like circumstances, with a little swelling and inflammation only arising in either case." Dr. Stradling has a rattlesnake that bit itself severely, with no more result than a little tumefaction of the wound; and it is still living and well.

Fading Photographs.—Common photographs, in which the dark parts consist of finely divided silver on a film of albumen, rarely remain unchanged in appearance for twenty years. The white parts sooner or later take on a sickly yellow tinge, and, when this change has begun, the picture is doomed, unless immediate steps are taken to preserve it. Treatment by skillful hands with a weak solution of mercuric chloride (corrosive sublimate) may arrest decay, but will not restore the clearness and freshness of the print. A better plan is to have the picture copied by some platinum-printing or carbon-printing photographer who does a large enough business to employ a skillful re-toucher. The process of getting a good permanent photograph from a bad fading one is complicated, and requires skill. Photographs in which the dark parts are formed of platinum-black are the most durable sort known. The best photographers will furnish permanent pictures if their sitters demand them, but such pictures are in plain black and white—without the chocolate tinge of the common style—unless the carbon process with a pigment of the requisite color is employed. The greatest enemies to the permanence of common silver-prints are traces of chemicals not fully washed out of the print, dampness, and the action of sulphur or its compounds. The last of these agencies is the most difficult to guard against. The albumen with which the photograph-paper is coated contains sulphur, and a familiar instance of its action is the blackening of silver egg-spoons. The air also, especially in cities, contains sulphurous gases derived from sewers, and from the burning of coal and gas.

Warmth for the Injured.—A correspondent of "The Lancet" urges the addition of some source of artificial heat to the equipment of ambulances in cold weather. "We all know," he says, "how depressed the system is after accidents; how difficult it is to restore warmth; and if to this we add exposure to a low temperature on the ground in frosty or wet weather, any amount of blankets can not add warmth, only retain what little there remains in the body. One need only picture one's meeting with an accident three or four miles from home, late in the evening, without additional clothing, lying for one or two hours on the damp ground, to realize how some means of conveying heat to the feet and hands would be welcomed." The writer then describes the means which he has used, consisting of a tin-lined copper bottle, holding a gallon and a half, and closed with a screw-plug. It is of concavo-convex shape, for feet, chest, etc. If filled with boiling water and rolled up in a blanket, it will remain quite hot for three hours, and be fairly warm after seven hours. Some of the hot water can be given to the injured person to drink, with the addition of beef-extract, spirits, cocoa, etc. He mentions also a particular pattern of kerosene stable-lamp, which, if placed inside a covered ambulance-wagon, would materially raise the temperature of the interior.

Boys' Color-Knowledge.—Some test examinations recently made in one of the English board-schools indicate that too much may have been made out of color-blindness, and that want of instruction rather than want of discrimination may be at fault in many of the cases where disability is supposed to exist. Some of the pupils at the examination in question were awkward at first, and made great mistakes, but needed only a little setting right to prove that they could distinguish the colors correctly. One boy was in the habit of calling black white and white black; as for the other colors, he had never been particular to name them, or think about them exactly, supposing it to be a matter of little importance. Of a hundred boys examined upon the seven principal colors, not one showed any real suspicion of color-blindness. Of two hundred boys examined in graduating and matching shades, none found any difficulty after practicing for about an hour; and every one was soon able to distinguish all the ordinary colors without the least difficulty.

Vitality of Microbes in Water.—According to Prof. Frankland's relation of experiments on the vitality of various microbes in water, great differences in behavior are observable. Of Koch's comma spirillum of Asiatic cholera, Finkler-Prior's comma spirillum of European cholera, and the *Bacillus pyocyaneus*, which produces the greenish-blue coloring in abscesses, the latter exhibits much greater vitality than either of the other two. It lives and increases many times for more than fifty days. Koch's comma spirillum disappeared from pure water in nine days, but flourished and increased in London sewage; while Finkler's spirillum disappeared in less than one day. In some cases when organisms not the natural inhabitants of water are introduced into it, a large proportion of them are at first destroyed, but a multiplication in numbers takes place afterward. The *Bacillus anthracis* in its bacillus form is destroyed with comparative ease, but the spores have remarkable vitality. Mr. Arthur Downes has remarked how, in tubes containing more than one form of microbe, the first dominant form will gradually grow more and more feeble until it seems to become extinct and is succeeded by races of a different kind.

The Arts of Life in Anthropology.—The one great feature which it is desirable to emphasize in anthropological museums, said Lieutenant-General Pitt-Rivers, in the British Association, is evolution. To impress upon the mind the continuity and historical sequence of the arts of life is one of the most important lessons to be inculcated. It is only of late years that the development of social institutions has at all entered into the design of educational histories. The arts of life have never formed part of any educational series. Yet, as a study of evolution, they are the most important of all, because in them the connecting links between the various phases of development can be better displayed. Laws, customs, and institutions may, perhaps, be regarded as of greater importance than the arts of life, but for anthropological purposes they are of less value, because in them, previous to the introduction of writing, the different phases of development, as soon as they are superseded by new ideas, are entirely lost, and can not be reproduced except in imagination; whereas in the arts of life, in which ideas are embodied in material forms, the connecting links are in many cases preserved, and can be replaced in their proper sequence by means of antiquities. For this reason the study of the arts of life ought always to precede the study of social evolution, in order that the student may learn to make allowance for missing links, and to avoid sophisms and the supposition of laws and tendencies which have no existence in reality. To ascertain the true causes for all the phenomena of human life is the main object of anthropological research, and it is obvious that this is better done in those branches in which the continuity is best preserved. In the study of natural history existing animals are regarded as present phases in the development of species, and their value to the biological student depends, not so much on their being of the highest organism, as on the paleontological sequence by which their history is capable of being established. In the same way existing laws, institutions, and arts, wherever they are found in their respective stages of perfection, are to be regarded simply as existing strata in the development of human life, and their value from an anthropological point of view depends on the facilities they afford for studying their history. The arts of life are of paramount importance, because they admit of being arranged in cases by means of antiquities in the order in which they were actually developed.

The Human Struggle for Existence.— The Malthusian theory was the subject of a discussion at the British Association. A paper by Mr. Edwin Chadwick went to show that, where wages increase, the pressure of population on means of subsistence is diminished; that, instead of the cost of production of land being fixed, it is generally reducible by science and machinery, while the amount of production may be everywhere augmented; and that, instead of pestilence being a natural check on population, it does not diminish its pressure, but serves to weaken the population and diminish its productive power and increase its pressure on the means of subsistence. The author could not descry the limits of a further advance of prosperity in the country with a further increase of population. Mr. Park Harrison thought that war was not an unmixed evil as a factor of population, and that it was interesting to note the care we took at present at vast expense to enable miserable specimens of humanity to survive and increase that part of the population which is really the main element of the unemployed. The members of society thus produced were perfectly incapable subjects, carefully nursed, and brought up as if they were going t oinherit large estates. Natural selection should be allowed to have fair play. It was interfering with the laws of nature to do so much in the direction of perpetuating the survival of the unfittest. Mr. W. L. Bros said that in old times war, by the operation of the rules that prevailed, eliminated the weakest members of society; but, by the system of fighting in the nineteenth century, the soldier should be a picked man of the community. The population, therefore, which suffered from war lost its best, not its worst members. War also added largely to the disproportion in the numbers of the sexes, and meant the prevalence of many social irregularities which tended to degrade the community as a whole, and to cause the survival of a lower type. Sociologists believe that the commercial competition of the present day is acting very much as war used to act in earlier days. The strong, the competent, and the mentally and physically efficient are succeeding in the struggle for life; the feeble in mind and body and in resources are being eliminated by industrial competition. It is desirable, in the interests of the health of the community, that this competition continue. Another speaker maintained that the children of the working classes did not, as a rule, contribute to the lazy population of the country. A poor man with six daughters practically owned a fortune, because they could become useful servants; and if he had three or four sons, the young men could obtain work if capable for it. It was the middle and higher classes who contributed to the surplus and lazy population. This could be seen by the large number of genteel young men who every day crowded after a vacant clerkship. Parents should not be afraid to bring up their sons to learn a useful handicraft.

NOTES.

The statistics of the Japanese Empire for 1887 show that commercial enterprise is developing there in a remarkable degree. The foreign trade of the country has increased more than 86 per cent in ten years. In connection with the addition of 151 miles of railway to the 370 miles before built, the pertinacity with which the Japanese insist upon furnishing their own capital, and not borrowing from abroad, is remarked upon. Naval stations are building at Kune, Nagasaki, and Tauchina Island. A system of water-works has been completed at Yokohama, while such concerns were wholly unknown under the old system; 111 commercial and industrial companies were formed last year in Tokio, Osaka, and Kioto, having an aggregate capital of \$21,500,000; and in all, shares to the extent of more than \$71,000,000 taken up by the people.

Dr. Joseph Wigglesworth, of Rainhill Asylum, regards morality as of developmental origin and growth. Morally insane persons exhibit a change in their affective nature, having their altruistic feelings greatly impaired or lost. Moral insanity might exist by itself, but it is more usually a stage in the development of intellectual insanity, showing itself generally precedent to intellectual change; the moral faculties are often the first to be affected when the cerebrum is the subject of slowly progressing disease. There are also moral idiots or imbeciles—children who, with little or no impairment of intellect, show great deficiency or almost total absence of the moral faculties, and are incapable of acquiring them.

The kava-root (*Piper methysticum*) of the Society and South Sea Islands is the basis of the intoxicating drink of those regions. Women and girls are employed to chew the root, and, when well masticated and mixed with saliva, it is ejected into bowls, mixed with coca-juice, and left to ferment. Both natives and whites of the lower classes are very fond of it. The natives use it as some among us do wine, under the idea that it will help them along in important undertakings.

The Franklin Institute calls attention to the fact that it is empowered to award a gold medal, founded by the legacy of Elliott Cresson, of Philadelphia, which is granted either for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufacture, or for ingenuity, skill, or perfection in workmanship. It is also empowered to recommend the award of a premium and medal, founded in 1816, by John Scott, of Edinburgh, by a legacy to the city of Philadelphia, for rewarding ingenious men and women who make useful inventions. The premium is not to exceed twenty dollars, and the medal is to be of copper, and inscribed "To the most deserving." Full information respecting the manner of presenting reports upon discoveries and inventions may be obtained by addressing the Secretary of the Franklin Institute, Philadelphia, Pa.

A technical university is contemplated in the colony of Victoria. A minute has been issued by the Minister of Public Instruction of the colony, on the policy of founding such an institution, in which the evidence taken before the Royal Commission on Technical Instruction is largely drawn upon. The estimates of cost embrace between £500,000 and £1,000,000 for founding the institution, and a yearly endowment of £30,000.

The district of Oulliassutai in Mongolia has been suffering for two years from an invasion of rats, which have destroyed all the grass of the pastures. The post-carriers have been obliged to change their routes, not only because of the difficulty of supporting relays of horses in the infested districts, but also because the roads have been made dangerous by innumerable burrows.

OBITUARIES.

It was recently announced that General Nicholas Prjevalsky, the distinguished Russian explorer, had died in Central Asia, on his way to Thibet, of typhus fever. He had started from St. Petersburg on the 31st of August, in an attempt to reach Lhassa, in Thibet. When last heard from previous to his death he had reached Vernoje, where he intended to equip his party. A portrait and sketch of him will be found in the number of this magazine for January, 1887.

Prof. Theodor Kjirulf, who has recently died at Christiania, Norway, besides being distinguished as a contributor to scientific literature, was versed in poetry and music, and a lover of the fine arts. He was born in Christiania in 1825; traveled in early life in Norway collecting folk-lore, and in Iceland, Tyrol, and other parts of Europe for geological study. He became attached to the geological department of the University of Christiania in 1850, and a professor there, and Director of the Geological Survey in 1866. He published works on the silurian basin of Christiania and the geology of southern Norway, and was the author of more popular books on scientific subjects.

James Stevenson, of the United States Geological Survey, died July 25th. He was born in Maysville, Ky., was business manager in the field of the Hayden Survey, was especially interested in American ethnology, and was a well-informed zoölogist.

Mr. William Gifford Palgrave, an eminent traveler, died at Montevideo, where he was British minister, in his sixty-third year. He was author of a "Narrative of a Year's Journey through Central and Eastern Arabia," which was a great fund of information respecting that little-known country.

Silas Stearns, an ichthyologist of thorough and exact knowledge, died at Asheville, N. C., August 2d. He was made a special agent in 1880 of the United States Fish Commission and Census Bureau, in charge of investigations of the marine industries of the Gulf of Mexico, with the fishes of which and their economical value he was particularly well acquainted. According to President Jordan, his early ambition to become a naturalist "met with discouragement in the absurd statement, made by some one in Washington, that no successful work in science would be possible without a classical education," but evidently was not put down by it.

Dr. Peter Gries, an English chemist, died September 6th, of apoplexy. He was best known from his discovery of the diazo compounds.

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THE

POPULAR SCIENCE MONTHLY.

FEBRUARY, 1889.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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"DEMONIACAL POSSESSION" AND INSANITY.

PART I.

OF all the triumphs won by science for humanity, none has been farther-reaching in its good effects than the modern treatment of the insane. But it is the result of a struggle long and severe between two great forces. On one side have stood the survivals of various superstitions, the metaphysics of various philosophies, the theologies of various religions, the literal interpretation of various sacred books, and especially of our own—all compacted into a creed that insanity is mainly or largely demoniacal possession; on the other side has stood science, gradually accumulating proofs that insanity is always the result of physical disease.

I purpose, in this chapter and the following, to sketch, as briefly as I may, the history of this warfare, or rather of this evolution of truth out of error.

Nothing is more simple and natural, in the early stages of civilization, than belief in occult, self-conscious powers of evil. Troubles and calamities come upon man; his ignorance of physical laws forbids him to attribute them to physical causes; he therefore attributes them sometimes to the wrath of a good being, but more frequently to the malice of an evil being.

Especially is this the case with diseases. The real causes of disease are so intricate that they are reached only after ages of scientific labor; hence they, above all, have been attributed to the influence of evil spirits.*

* On the general attribution of disease to demoniacal influence, see Sprenger, "History of Medicine," *passim* (note, for a later attitude, ii, 150-170, 178); Calmeil, "De la Folie,"

But, if ordinary diseases were likely to be attributed to diabolical agency, how much more diseases of the brain, and especially the more obscure of these! These, indeed, seemed to the vast majority of mankind possible only on the theory of satanic intervention. Any approach to a true theory of the connection between physical causes and mental results is one of the highest acquisitions of science.

Here and there, during the whole historic period, keen men had obtained an inkling of the truth; but, to the vast multitude, down to the end of the seventeenth century, nothing was more clear than that insanity is in many, if not in most, cases demoniacal possession.

Yet at a very early date, in Greece and Rome, science asserted itself, and a beginning was made which seemed destined to bring a large fruitage of blessings.* In the fifth century before the Christian era, Hippocrates of Cos asserted the great truth that all madness is simply disease of the brain, thereby beginning a noble development of truth and mercy which lasted nearly a thousand years. In the first century after Christ, Aretæus carried these ideas yet further, observed the phenomena of insanity with great acuteness, and reached yet more valuable results. Near the beginning of the following century, Soranus went still further in the same path, giving new results of research, and strengthening scientific truth. Toward the end of the same century, a new epoch was ushered in by Galen, under whom the same truth was developed yet further, and the path toward merciful treatment of the insane made yet more clear. In the third century came Celius Aurelianus, who received this deposit of precious truth, elaborated it, and brought forth the great idea which, had theology, citing Biblical texts, not banished it, would

Paris, 1845, i, 104, 105; Esquirol, "Des Maladies Mentales," Paris, 1838, i, 482; also Tylor, "Primitive Culture." For a very plain and honest statement of this view in our own sacred books, see Oort, Hooykaas, and Kuenen, "The Bible for Young People," English translation, v, 167, and following; also Farrar's "Life of Christ," chap. xvii. For this idea in Greece and elsewhere, see Maury, "La Magie," etc., iii, 276, giving, among other citations, one from book v of the "Odyssey." On the influence of Platonism, see Esquirol and others, as above—the main passage cited is from the "Phædo." For the devotion of the early fathers and doctors to this idea, see citations from Eusebius, Lactantius, St. Jerome, St. Augustine, St. John Chrysostom, St. Gregory Nazianzen, in Tissot, "L'Imagination," p. 369; also Jacob (i. e., Paul Lacroix), "Croyances Populaires," p. 183. For St. Augustine, see also his "De Civitate Dei," lib. 22, cap. viii, and his "Enarratio in Psal.," cxxxv, 1. For the breaking away of the religious orders in Italy from the entire supremacy of this idea, see Becavin, "L'École de Salerne," Paris, 1888; also Daremberg, "Histoire de la Médecine." Even so late as the Protestant Reformation, Martin Luther maintained ("Table-Talk," Hazlitt's translation, London, 1872, pp. 250–256) that "Satan produces all the maladies which afflict mankind."

* It is significant of this scientific attitude that the Greek word for superstition signifies, literally, fear of gods or demons.

have saved fifteen centuries of cruelty—a truth not fully recognized again till near the beginning of the present century—the truth that insanity is brain-disease, and that the treatment of it must be gentle and kind. In the sixth century Alexander of Tralles presented still more fruitful researches, and taught the world how to deal with *melancholia*; and, finally, in the seventh century, this great line of scientific men, working mainly under pagan auspices, was closed by Paul of Ægina, who, under the protection of Caliph Omar, made still further observations and additions to truth, but, above all, laid stress on the cure of madness as a disease, and on the absolute necessity of mild treatment.

Such was this great succession in the apostolate of truth; evidently no other has ever shown itself more directly under divine grace, illumination, and guidance. It had given to the world what might have been one of its greatest blessings.*

But, most unfortunately, there set into the early Church a current of belief which was destined to bring all these noble acquisitions of science and religion to naught, and, during centuries, to inflict tortures, physical and mental, upon hundreds of thousands of innocent men and women—a belief which held its cruel sway for nearly eighteen centuries; and this belief was that madness was mainly or largely possession by the Devil.

This idea of diabolic agency in mental disease grew luxuriantly in all the Oriental sacred literatures, and especially in that of the Jews. Such cases in the Old Testament as the evil spirit in Saul, which we now see to have been simply melancholy, and in the New Testament the various accounts of the casting out of devils, through which is refracted the beautiful and simple story of that power by which Jesus of Nazareth soothed perturbed minds by his presence or quelled outbursts of madness by his word, give abundant examples of this. In Greece, too, an idea akin to this found lodgment both in the popular belief and in the philosophy of Plato and Socrates; † and though, as we have seen, the great leaders in medical science had taught with more or less distinctness that insanity is the result of physical disease, there was a

* For authorities regarding this development of scientific truth and mercy in antiquity, see especially Kraft-Ebing, "Lehrbuch der Psychiatrie," Stuttgart, 1888, p. 40 and the pages following; Trélat, "Recherches Historiques sur la Folie," Paris, 1839; Semelaigne, "L'Aliénation mentale dans l'Antiquité," Paris, 1869; Dagron, "Des Aliénés," Paris, 1875; also Calmeil, "De la Folie," Sprenger, and especially Isensée, "Geschichte der Medicin," Berlin, 1840.

† It is, indeed, extremely doubtful whether Plato himself or his contemporaries knew anything of *evil* demons, this conception probably coming into the Greek world, as into the Latin, with the Oriental influences that began to prevail about the time of the birth of Christ; but to the early Christians a demon was a demon, and Plato's, good or bad, were pagan, and therefore devils.

strong popular tendency to attribute the more troublesome cases of it to hostile spiritual influence.*

From all these sources, but especially from our sacred books and the writings of Plato, this theory that mental disease is caused largely or mainly by satanic influence passed into the early Church. In the apostolic times no belief seems to have been more firmly settled. The early Fathers and Doctors in the following age universally accepted it, and the apologists generally spoke of the power of casting out devils as a leading proof of the divine origin of the Christian religion.†

As a result of this idea, the Christian Church at an early period in its existence virtually gave up the noble conquests of Greek and Roman science in this field, and originated a regular discipline for persons supposed to be possessed, based, as was believed, upon Scriptural theology. But, during the centuries before theology and ecclesiasticism were largely developed, this discipline was, as a rule, gentle and useful. The afflicted, when not too violent, were generally admitted to the exercises of public worship, and a kindly system of cure was attempted, in which prominence was given to holy water, sanctified ointments, the breath or spittle of the priest, the touching of relics, visits to holy places, and submission to mild forms of exorcism. There can be no doubt that many of these things, when judiciously used, in that spirit of love and gentleness and devotion inherited by the earlier disciples from "the Master," produced good effects in soothing disturbed minds and aiding their cure.

Among the thousands of fetiches of various sorts then resorted to may be named, as typical, the Holy Handkerchief of Besançon. During many centuries multitudes came from far and near to be touched by it; for, it was argued, if touching the garments of St. Paul, at Ephesus, had cured the diseased, how much more might be expected of a handkerchief of the Lord himself!

With ideas of this sort was mingled a vague belief in medical

* The Greek word "epilepsy" is itself a survival of the old belief, fossilized in a word, since its literal meaning refers to the *seizure* of the patient by evil spirits.

† For a striking statement of the Jewish belief in diabolical interference, see Josephus, "De Bello Judaico," vii, 6, iii; also his "Antiquities," viii, Whiston's translation. On the "devil cast out," in Mark ix, 17–29, as an undoubted case of epilepsy, see Cherullier, "Essai sur l'Épilepsie"; also Maury, art. "Démoniaque" in the "Encyclopédie Moderne." In one text, at least, the popular belief is perfectly shown as confounding madness and possession: "He hath a devil and is mad," John x, 20. Among the multitude of texts those most relied upon were Matthew viii, 28, and Luke x, 17; and, for the use of fetiches in driving out evil spirits, the account of the cures wrought by touching the garments of St. Paul in Acts xix, 12. On the general subject see authorities already given, and as a typical passage Tertullian, "ad. Scap.," ii; for the very gross view taken by St. Basil, see Cudworth, "Intellectual System," ii, 648; also Archdeacon Farrar's "Life of Christ." For a curious presentation of Greek views, see Lélut, "Le Démon de Socrate," Paris, 1886; and, for the transmission of these to Christianity, see same, p. 201, and following.

treatment, and out of this mixture were evolved such prescriptions as the following:

"If an elf or a goblin come, smear his forehead with this salve, put it on his eyes, cense him with incense, and sign him frequently with the sign of the cross."

"For a fiend-sick man: When a devil possesses a man, or controls him from within with disease, a spew-drink of lupin, bishopswort, henbane, garlic. Pound these together, add ale and holy water."

And again: "A drink for a fiend-sick man, to be drunk out of a church-bell: Githrife, cynoglossum, yarrow, lupin, flower-de-luce, fennel, lichen, lovage. Work up to a drink with clear ale, sing seven masses over it, add garlic and holy water, and let the possessed sing the *Beati Immaculati*; then let him drink the dose out of a church-bell, and let the priest sing over him the *Domine Sancte Pater Omnipotens*." *

Had this been the worst treatment of lunatics developed in the theological atmosphere of the middle ages, the world would have been spared some of the most terrible chapters in its history; but, unfortunately, the idea of the Satanic possession of lunatics led to attempts to punish the indwelling demon. As this theological theory and practice became more fully developed, and ecclesiasticism more powerful to enforce it, all mildness began to change, or to be driven into remote corners of Christendom; the admonitions to gentle treatment by the great pagan and Moslem physicians were forgotten, and the treatment of lunatics tended more and more toward severity; more and more generally it was felt that cruelty to madmen was punishment of the devil residing within or acting upon them.

A few strong churchmen and laymen made efforts to resist this tendency. As far back as the fourth century, Nemesius, Bishop of Emesa, accepted the truth as developed by pagan physicians, and aided them in strengthening it. In the seventh century, a Lombard code embodied a similar effort. In the eighth century, one of Charlemagne's capitularies seems to have had a like purpose. In the ninth century, that great churchman and statesman, Agobard, Archbishop of Lyons, superior to his time in this as in so many other things, tried to make right reason prevail in this field; and, near the beginning of the tenth century, Regino, Abbot of Prüm, in the diocese of Treves, insisted on treating possession as disease. But all in vain; the current streaming most directly from sundry texts in the Christian sacred books, and swollen by theology, had become overwhelming. †

* See Cockayne, "Leechdoms, Wort-cunning, and Star-Craft of Early England" (in the Rolls Series), ii, 177; also 355, 356. For the great value of priestly saliva, see W. W. Story's interesting essays.

† For a very thorough and interesting statement on the general subject, see Kirchhof,

The first great tributary poured into this stream, as we approach the bloom of the middle ages, appears to have come from the brain of Michael Psellus. Mingling scriptural texts, Platonic philosophy, and theological views of great doctors of the Church, with wild statements obtained from lunatics, he gave forth, about the beginning of the twelfth century, a treatise on "The Work of Demons." "Sacred science" was vastly enriched thereby in various ways; but two of his conclusions, the results of his most profound thought, enforced by theologians and popularized by preachers, soon took a special hold upon the thinking portion of the people at large. The first of these, which he easily based upon Scripture and St. Basil, was that, since all demons suffer by material fire and brimstone, they must have material bodies; the second was that, since all demons are by nature cold, they gladly seek a genial warmth by entering the bodies of men and beasts.*

Fed by this stream of thought, and developed in the warm atmosphere of mediæval devotion, the idea of demoniacal possession as the main source of lunacy grew and blossomed and bore fruit in noxious luxuriance.

There had, indeed, come into the middle ages an inheritance of scientific thought. The ideas of Hippocrates, Celius Aurelianus, Galen, and their followers, were from time to time revived; the Arabian physicians, the school of Salerno, such writers as Salicetus, Guy de Chauliac, and even some of the religious orders, did something to keep scientific doctrines alive; but the tide of theological thought was too strong—it became dangerous even to seem to name possible limits to diabolical power. To deny Satan was atheism; and perhaps nothing did so much to fasten the epithet "atheist" upon the medical profession as the suspicion that it did not fully acknowledge diabolical interference in mental disease. Of this feeling we have a monument in the mediæval proverb, "Where there are three physicians there are two atheists." Fol-

"Beziehungen des Dämonen- und Hexenwesens zur deutschen Irrenpflege," in the "Allgemeine Zeitschrift für Psychiatrie," Berlin, 1888, Bd. xliv, Hft. 25. For Roman Catholic authority, see Addis and Arnold, "Catholic Dictionary," article "Emergumens." For a brief and eloquent summary, see Kraft-Ebing, "Lehrbuch der Psychiatrie," as above; and, for a clear view of the transition from pagan mildness in the care of the insane to severity and cruelty under the Christian Church, see Maudsley, "The Pathology of Mind," London, 1879, p. 523. See also Buchmann, "Die unfreie und die freie Kirche," Breslau, 1873, p. 251. For other citations, see Kirchhof, as above, pp. 334–336. For Bishop Nemesius, see "Trélat," p. 48. For an admirable account of Agobard's general position in regard to this and allied superstitions, see Reginald Lane Poole's "Illustrations of the History of Mediæval Thought," London, 1884.

* See Baas and Werner, cited by Kirchhof, as above; also Lecky, "Rationalism in Europe," i, 68, and note, New York, 1884. As to Basil's belief in the corporeality of devils, see his "Commentary on Isaiah," cap. i.

lowing in the lines of the earlier fathers, St. Anselm, Abélard, St. Thomas Aquinas, Vincent de Beauvais, all the great doctors in the mediæval Church, some of them in spite of occasional misgivings, upheld the idea that insanity is largely or mainly demoniacal possession, basing their belief steadily on the sacred Scriptures; and this belief was followed up in every quarter by more and more constant citation of the text "Ye shall not suffer a witch to live." No other text of Scripture—save, perhaps, one—has caused the shedding of so much innocent blood.

As we look over the history of the middle ages, we do, indeed, see another development from which one might hope much; for there were two great streams of influence in the Church—and never were two powers more truly unlike each other.

On one side was the spirit of Christianity, as it proceeded from the heart and mind of its blessed Founder, immensely powerful in aiding the evolution of religious thought and effort, and especially of provision for the relief of suffering by religious asylums and tender care. Nothing better expresses this than the touching words inscribed upon a great mediæval hospital, "*Christo in pauperibus suis.*" But on the other side was the theological theory—proceeding, as we have seen, from the survival of ancient superstitions, and sustained by constant reference to the texts in our sacred books—that many, and probably most, of the insane were possessed by the devil or in league with him, and that the cruel treatment of lunatics was simply punishment of the devil and his minions. By this current of thought was gradually developed one of the greatest masses of superstitious cruelty that has ever disgraced humanity. At the same time the stream of Christian endeavor, so far as the insane were concerned, was almost entirely cut off. In all the beautiful provision during the middle ages for the alleviation of human suffering, there was for the insane almost no care. Some monasteries, indeed, gave them refuge. We hear of a charitable work done for them at the London Bethlehem Hospital in the thirteenth century, at Geneva in the fifteenth, at Marseilles in the sixteenth, by the Black Penitents in the south of France, by certain Franciscans in northern France, by the Alexian Brothers on the Rhine, and by various agencies in other parts of Europe.

Curiously enough, the only really important effort in the Christian Church was stimulated by the Mohammedans. Certain monks, who had much to do with them in redeeming Christian slaves, found in the fifteenth century what John Howard found in the eighteenth, that the Arabs and Turks made a large and merciful provision for lunatics, such as was not seen in Christian lands; and this example led to better establishments in Spain and Italy.

All honor to this work and to the men who engaged in it; but, as a rule, these establishments were few and poor, compared with those for other diseases, and they usually degenerated into madhouses, where devils were cast out mainly by cruelty.*

The first main weapon against the indwelling Satan continued to be the exorcism; but, under the influence of inferences from Scripture farther and farther fetched, and of theological reasoning more and more subtle, it became something very different from the gentle procedure of earlier times, and some description of this great weapon at the time of its highest development will throw light on the laws which govern the growth of theological reasoning, as well as upon the main subject in hand.

A fundamental premise in the fully developed exorcism was that, according to sacred Scripture, a main characteristic of Satan is pride. Pride led him to rebel—for pride he was cast down; therefore the first thing to do, in driving him out of a lunatic, was to strike a fatal blow at this pride—to disgust him.

This theory was carried out logically, to the letter. The treatises on the subject simply astound one by their wealth of epithets—blasphemous and obscene—which it was allowable for the exorcist to use in casting out devils. The "Treasury of Exorcisms" † contains hundreds of pages packed with the vilest epithets which the worst imagination could invent for the purpose of overwhelming the indwelling Satan.

Some of those decent enough to be printed in these degenerate days ran as follows:

"Thou lustful and stupid one, . . . thou lean sow, famine-stricken and most impure, . . . thou wrinkled beast, thou mangy beast, thou beast of all beasts the most beastly, . . . thou mad

* For a very full and learned, if somewhat one-sided, account of the earlier effects of this stream of charitable thought, see Vollemer, "Des Origines de la Charité Catholique," Paris, 1858. It is instructive to note that, while this book is very full in regard to the action of the Church on slavery and on provision for the widows and orphans, the sick, the infirm, captives, and lepers, there is hardly a trace of any care for the insane. This same want is incidentally shown by a typical example in Kriegk, "Aerzte, Heilanstalten und Geisteskranke im mittelalterlichen Frankfurt," Frankfurt a. M., 1863, pp. 16, 17; also Kirchhof, pp. 396, 397. On the general subject, see Semelaigne, as above, p. 214; also Lecky, "Rationalism in Europe," i, 88; also Calmeil, i, 116, 117. For the effect of Moslem example in Spain and Italy, see Kraft-Ebing, as above, p. 45, note.

† "Thesaurus Exorcismorum atque Conjurationum terribilium, potentissimorum, efficacissimorum, cum PRACTICA probatissima: quibus spiritus maligni, Dæmones Maleficiaque omnia de Corporibus humanis obsessis, tanquam Flagillis Fustibusque fugantur, expelluntur," . . . Cologne, 1626. Many of the books of the exorcists were put upon the various indexes of the Church, but this, the richest collection of all, and including nearly all those condemned, was not prohibited until 1709. Scarcely less startling manuals continued even later in use; and exorcisms adapted to every emergency may, of course, still be found in all the Benedictionals of the Church—even the latest. As an example, see the "Manuale Benedictionum" published by the Bishop of Passau in 1849.

spirit, . . . thou bestial and foolish drunkard, . . . most greedy wolf, . . . most abominable whisperer, . . . thou sooty spirit from Tartarus! . . . I cast thee down, O Tartarean boor, into the infernal kitchen! . . . Loathsome cobbler, . . . dingy collier, . . . filthy sow (*scrofa stercorata*), . . . perfidious boar, . . . envious crocodile, . . . malodorous drudge, . . . wounded basilisk, . . . rust-colored asp, . . . swollen toad, . . . entangled spider, . . . lousy swineherd (*porcarie pedicose*), . . . lowest of the low, . . . cudgeled ass," etc.

But, in addition to this attempt to disgust Satan's pride with blackguardism, there was another to scare him with tremendous words. For this purpose, great, sounding names, from Hebrew and Greek, of the Deity were imported, such as Acharon, Eheye, Schemhamphora, Tetragrammaton, Homousion, Ho Theos, Athanatos, Ischiros, Æcodes, and the like.*

Efforts were also made to drive him out with filthy and rank-smelling drugs; and, among those which can be mentioned in a printed article, we may name asafœtida, sulphur, squills, etc., which were to be burned under his nose.

Still further to plague him, pictures of the devil were to be spat upon, trampled under foot by people of low condition, and sprinkled with foul compounds.

But these were merely preliminaries to the exorcism proper. In this the most profound theological thought and sacred science of the period culminated.

Most of its forms were childish, but some rise to almost Miltonic grandeur. As an example of the latter, we may take the following:

"By the Apocalypse of Jesus Christ, which God hath given to make known unto his servants those things which are shortly to take place; and hath signified, sending by his angel, . . . I exorcise you, ye angels of untold perversity!

"By Him that is the faithful witness, the first-born among the dead, and the Prince of the kings of the earth, . . . I exorcise you, ye dwellers in the regions of hell!

"And by Him that loved us, and washed us of our sins in his blood, . . . and behold, he cometh in clouds, and every eye shall see him, and they also who pierced him; and all the tribes of the earth shall weep before him; . . . and by all the wondrous signs, terrible voices, mighty thunders, and mystic visions which St. John beheld, I exorcise you, O angels who entice unto evil deeds, that ye do go far away from this creature!

"By the seven golden candlesticks, . . . and by one like unto the Son of man, standing in the midst of the candlesticks; by

* See the *Conjuratio* on p. 300 of the "Thesaurus," and the general directions given on pp. 251, 252.

this voice, as the voice of many waters; . . . by his words, 'I am living, who was dead; and behold, I live forever and ever; and I have the keys of death and of hell,' I say unto you, Depart, O angels that show the way to eternal perdition!

"By the door which John saw open in heaven; by the twenty-four thrones and the twenty-four elders, . . . and by the lightnings and thunders and voices which proceeded out from the throne; . . . by the sea which he saw, as it were of glass mingled with fire, . . . and by the four living beings full of eyes before and behind; . . . by the words which they incessantly did say, 'Holy, holy, holy, Lord God Almighty, that was, and that is, and that is to come'; . . . by the angel who cried out, 'Who is worthy to open the book, and to loose the seals?' . . . by the Lamb, as it were slain; . . . by the harps and by the vials of gold, full of perfumes, I charge ye, O angels of death, to flee quickly out of this creature!"

Besides these, were long litanies of billingsgate, cursing, and threatening. One of these "scourging" exorcisms runs partly as follows:

"May Agyos strike thee, as he did Egypt, with frogs! . . . May all the devils that are thy foes rush forth upon thee, and drag thee down to hell! . . . May . . . Tetragrammaton . . . drive thee forth and stone thee, as Israel did to Achan! . . . May the holy one trample on thee and hang thee up in an infernal fork, as was done to the five kings of the Amorites! . . . May God set a nail to your skull, and pound it in with a hammer, as Jael did unto Sisera! . . . May . . . Sother . . . break thy head and cut off thy hands, as was done to the cursed Dagon! . . . May God hang thee in a hellish yoke, as seven men were hung by the sons of Saul!" And so on, through five pages of close-printed Latin curses.*

Occasionally the demon is reasoned with, as follows: "O obstinate, accursed, fly! . . . why do you stop and hold back when you know that your strength is lost on Christ? For it is hard for thee to kick against the pricks; and, verily, the longer it takes you to go, the worse it will go with you. Begone, then, take flight, thou venomous hisser, thou lying worm, thou begetter of vipers!" †

And this procedure and its results were recognized as among the glories of the Church. As typical, we may mention an exorcism directed by a certain Bishop of Beauvais, which was so effective that five devils gave up possession of a sufferer and signed their names, each for himself and his subordinate imps, to an agreement that the possessed should be molested no more. So, too, the Jesuit fathers at Vienna, in 1583, gloried in the fact that

* "Thesaurus Exorcismorum," 812–817. † Ibid., 859.

in such a contest they had cast out twelve thousand six hundred and fifty-two living devils. The ecclesiastical annals of the middle ages, and, indeed, of a later period, abound in boasts of such "mighty works."*

Such was the great result of a thousand years of theological reasoning, by the strongest minds in Europe, upon data given in Scripture regarding Satan and his work among men. Such were the results and remedies arrived at by the highest development of "sacred science."

Under the guidance of theology, always so severe against "science falsely so called," the world had come a long way indeed from the soothing treatment of the possessed by Him who bore among the noblest of his titles that of "The Great Physician." The result was natural: the treatment of the insane fell more and more into the hands of the jailer, the torturer, and the executioner.

To go back for a moment to the beginnings of this unfortunate development. In spite of the earlier and more kindly tendency in the Church, the Synod of Ancyra, as early as 35 A. D., commanded the expulsion of possessed persons from the Church; the Visigothic Christians whipped them; and Charlemagne, in spite of some good enactments, imprisoned them. Men and women, whose distempered minds might have been restored to health by gentleness and skill, were driven into hopeless madness by noxious medicines and brutality. Some few were saved as mere lunatics —they were surrendered to general carelessness, and became simply a prey to ridicule and aimless brutality; but vast numbers were punished as tabernacles of Satan.

One of the least terrible of these punishments, and perhaps the most common of all, was that of scourging demons out of the body of a lunatic. This method commended itself even to the judgment of so thoughtful and kindly a personage as Sir Thomas More, and as late as the sixteenth century. But if the disease continued, as it naturally would after such treatment, the authorities frequently felt justified in driving out the demons by torture.†

Interesting monuments of this idea, so fruitful in evil, still exist. In the great cities of central Europe, "witch-towers," where witches and demoniacs were tortured, and "fool-towers," where the more gentle lunatics were imprisoned, may still be seen.

* In my previous chapters—especially that on meteorology—I have quoted extensively from the original treatises, of which a very large collection is in my possession; but in this chapter I have largely availed myself of the copious translations given by M. H. Dziewicki, in his excellent article in the "Nineteenth Century" for October, 1888, entitled "Exorcizo Te." For valuable citations on the origin and spread of exorcism, see Lecky's "European Morals" (third English edition), i, 379–385.

† For prescription of the whipping-post by Sir Thomas More, see D. H. Tuke's "History of Insanity in the British Isles," London, 1882, pp. 29, 30.

In the cathedrals, too, we still see this idea fossilized. Devils and imps, struck into stone, clamber upon towers, prowl under cornices, peer out from bosses of foliage, perch upon capitals, nestle under benches, flame in windows. Above the great main entrance, the most common of all representations still shows Satan and his imps scowling, jeering, grinning, while taking possession of the souls of men and scourging them with serpents, or driving them with tridents, or dragging them with chains, into the flaming mouth of hell. Even in the most hidden and sacred places of the mediæval cathedral we still find representations of Satanic power in which profanity and obscenity run riot. In these representations the painter and glass-stainer vied with the sculptor. Among the early paintings on canvas a well-known example represents the devil in the shape of a dragon, perched near the head of a dying man, eager to seize his soul as it issues from his mouth, and only kept off by the efforts of the attendant priest. Typical are the colossal portrait of Satan, and a vivid picture of the devils cast out of the possessed and entering into the swine, as shown in the cathedral-windows of Strasburg. So, too, in the windows of Chartres Cathedral we see a saint healing a lunatic—the saint, with a long devil-scaring formula in Latin issuing from his mouth; and the lunatic, with a little detestable hobgoblin, horned, hoofed, and tailed, issuing from *his* mouth. These examples are but typical of myriads in cathedrals and abbeys and parish churches throughout Europe; and all served to impress upon the popular mind a horror of everything called diabolic, and a hatred of those charged with it. These sermons in stones preceded the printed book; they were a sculptured edition of the Bible, which preceded the pictorial editions of Luther's printed Bible.*

Satan and his imps were among the principal personages in every popular drama, and "Hell's Mouth" was a piece of stage scenery constantly brought into requisition. A miracle-play, without a full display of the diabolic element in it, would have stood a fair chance of being pelted from the stage.†

* I cite these instances out of a vast number which I have personally noted in visits to various cathedrals. For striking examples of mediæval grotesques, see Wright's "History of Caricature and the Grotesque," London, 1875; Langlais's "Stalles de la Cathédrale de Rouen," 1838; Champfleury's "Les Sculptures Grotesques et Symboliques," Rouen, 1879; Viollet le Duc, "Dictionnaire de l'Architecture"; Gailhabaud, "Sur l'Architecture," etc.

† See Wright, "History of Caricature and the Grotesque"; F. J. Mone, "Schauspiele des Mittelalters," Carlsruhe, 1846; Dr. Karl Hase, "Miracle Plays and Sacred Dramas," Boston, 1880 (translation from the German). Examples of the miracle-plays may be found in Mone; in Mariott's "Collection of English Miracle-Plays," Basil, 1838; in Hone's "Ancient Mysteries"; in T. Sharp's "Dissertation on the Pageants . . . anciently performed at Coventry," Coventry, 1828; in the publications of the Shakespearean and other societies. See especially the "Harrowing of Hell," a miracle-play, edited from the original now in the British Museum, by T. O. Halliwell, London, 1840. One of the items still preserved is a

The especial point to be noted is that from the miracle-play of the present day Satan and his works have disappeared. The writer of this article was unable to detect, in a representation of the passion-play at Ober-Ammergau, in 1881, the slightest reference to diabolic interference with the course of events as represented from the Old Testament, or from the New, in a series of tableaux lasting, with a slight intermission, from nine in the morning until after four in the afternoon. With the most thorough exhibition of minute events relating the life of Christ, and at times with hundreds of figures on the stage, there was not a person or a word which recalled that main feature in the mediæval Church plays. The writer also made a full collection of photographs of tableaux, of engravings of music, and of works bearing upon these representations for twenty years before, and in none of these was there an apparent survival of the old belief. This would certainly seem to indicate that even the child-like faith of the Tyrolese has arrived at a point, under modern influences, which would make a representation of Satan and his minions incongruous; and that, while they believe that they believe, diabolism as a belief to be openly professed has become a thing to provoke derision.*

Not only the popular art, but all the popular legends embodied these ideas. The stories of the chroniclers are full of them; the "Lives of the Saints" abound in them; sermons enforced them from every pulpit. What wonder, then, that soon men and women had vivid dreams of Satanic influence, that dread of "possession" was like dread of the plague, and that this terror spread the disease enormously, until we hear of convents, villages, and even large districts ravaged by epidemics of diabolical possession! †

And this terror naturally bred not only active cruelty toward those supposed to be possessed, but cold indifference to the sufferings of those acknowledged to be lunatics. As we have already seen, while ample and beautiful provision was made for every other form of human suffering, for this there was comparatively little; and, indeed, what provision was made was generally worse than none. Of this indifference and cruelty we have a striking monument in a single English word—a word originally significant

sum of money paid for keeping a fire burning in hell's mouth. Says Hase (as above, p. 42): "In wonderful satyr-like masquerade, in which neither horns, tail, nor hoofs were ever . . . wanting, the devil prosecuted on the stage his business of fetching souls," which left the mouths of the dying "in the form of small images."

* Speaking of the part played by Satan at Ober-Ammergau, Hase says: "Formerly, seated on his infernal throne, surrounded by his hosts with Sin and Death, he opened the play, . . . and . . . retained throughout a considerable part; but he has been surrendered to the progress of that enlightenment which even the Bavarian highlands have not been able to escape" (p. 80).

† I shall discuss these epidemics of possession, which form a somewhat distinct class of phenomena, in the second part of this chapter.

of gentleness and mercy, but which became significant of wild riot and brutality and confusion—Bethlehem Hospital became "Bedlam."

Modern art has also dwelt upon this theme, and perhaps the most touching of all its exhibitions is the picture by a great French master representing a tender woman bound to a column, and exposed to the jeers, insults, and missiles of street ruffians.*

Here and there, even in the worst of times, men arose who attempted to promote a more humane view, but with little effect. One expositor of St. Matthew, having ventured to recall the fact that some of the insane were spoken of in the New Testament as madmen, and to suggest that their madness might be caused by the moon, was answered that their madness was not caused by the moon, but by the devil, who avails himself of the moonlight for his work.†

One result of this idea was a mode of cure which especially aggravated and spread mental disease—the promotion of great religious processions. Troops of men and women, crying, howling, imploring saints, beating themselves with whips, visited various sacred shrines, images, and places, in the hope of driving off the powers of evil. The only result was an increase in the numbers of the diseased.

For hundreds of years this idea of diabolic possession was steadily developed. It was believed that devils entered into animals; and animals were accordingly exorcised, tried, tortured, convicted, and executed. The great St. Ambrose tells us that a priest, while saying mass, was troubled by the croaking of frogs in a neighboring marsh, and that he exorcised them, and so stopped their noise. St. Bernard, as the monkish chroniclers tell us, mounting the pulpit to preach in his abbey, was interrupted by a cloud of flies; straightway the saint uttered the sacred formula of excommunication, when the flies fell dead upon the pavement in heaps, and were cast out with shovels! A formula of exorcism attributed to a saint of the ninth century, and which remained in use down to a recent period, especially declares insects injurious to crops to be possessed of evil spirits, and names, among the animals to be excommunicated or exorcised, mice, moles, and serpents. The use of exorcism against caterpillars and grasshoppers was also common. In the thirteenth century the Bishop of Lausanne, finding that the eels in Lake Leman troubled the fishermen, attempted to remove the difficulty by exorcism.

* The typical picture representing a priest's struggle with the devil is in the city gallery of Rouen. The modern picture is Robert Fleury's painting in the Luxembourg Gallery at Paris.

† See Giraldus Cambrensis, cited by Tuke, as above, p. 79.

Did any one venture to deny that animals could be possessed by Satan, he was at once silenced by reference to the entrance of Satan into the serpent in the garden of Eden, to the transformation of Nebuchadnezzar, and to the casting of the devils into the swine by the founder of Christianity himself.*

One part of this superstition most tenaciously held was the belief that a human being could be changed into the form of an animal. This became, indeed, a fundamental point. The most dreaded of predatory animals in the middle ages were the wolves. Driven from the hills and forests in the winter by hunger, they not only devoured the flocks, but sometimes came into the villages and seized children. From time to time men and women whose brains were disordered dreamed that they had been changed into various animals, and especially into wolves. Confessing this, and often implicating others, many executions of lunatics resulted; not to mention here the countless sane victims who, suspected of the same impossible crime, were forced by torture into confession of it, and sent unpitied to the stake. The belief in such a transformation pervaded all Europe, and lasted long, even in Protestant countries; probably no article in the witch creed had more adherents in the fifteenth, sixteenth, and seventeenth centuries than this. Nearly every parish in Europe had its resultant horrors.

The Reformed Church in all its branches fully accepted the doctrines of witchcraft and diabolic possession, and developed them still further. No one urged their fundamental ideas more fully than Luther. He did, indeed, reject portions of the witchcraft folly; but to the influence of devils he not only attributed his maladies but his dreams, and nearly everything that thwarted or disturbed him. The flies which lighted upon his book, the rats which kept him awake at night, he believed to be devils; the resistance of the Archbishop of Mayence to his ideas, he attributed to Satan literally working in that prelate's heart; to his disciples he told stories of men who had been killed by rashly resisting the devil. Insanity, he was quite sure, was caused by Satan, and he exorcised sufferers. Against some he appears to have advised stronger remedies; and his horror of idiocy, as resulting from satanic influence, was so great that on one occasion he appears to have advised the killing of an idiot child, as being the direct offspring of Satan. Yet Luther was one of the most tender and loving of men; in the whole range of literature there is hardly anything more touching than his words and tributes to children. In enforcing his ideas he laid stress especially upon the question of St. Paul as to the bewitching of the Galatians, and, in the case

* See Menabrea, "Procès au Moyen Age contre les Animaux," Chambéry, 1846, pp. 31 and following.

of idiocy, on the account in Genesis of the birth of children whose fathers were "sons of God" and whose mothers were "daughters of men."

One idea of his was especially characteristic. The descent of Christ into hell was a frequent topic of discussion in the Reformed Church; Melanchthon, with his love of Greek studies, held that the purpose of the Saviour was to make himself known to the great and noble men of antiquity—Plato, Socrates, and the rest; but Luther insisted that his purpose was to conquer Satan in a hand-to-hand struggle.

This idea of diabolic influence pervaded his conversation, his preaching, and his writings, and spread thence to the Lutheran Church in general.

Calvin also held to the same theory; and, having more power, with less kindness of heart, than Luther, carried it out with yet greater harshness.

Under the influence, then, of such infallible teachings, in the older Church and in the new, this superstition was developed more and more into cruelty; and, as the Biblical texts, popularized in the sculptures and windows and mural decorations of the great mediæval cathedrals, had done much to develop it among the people, so Luther's translation of the Bible, especially in the numerous editions of it illustrated with engravings, wrought with enormous power to spread and deepen it. In every peasant's cottage some one could spell out the story of the devil bearing Christ through the air and placing him upon the pinnacle of the Temple,—of the woman with seven devils,—of the devils cast into the swine. Every peasant's child could be made to understand the quaint pictures in the family Bible or the catechism which illustrated vividly all those texts. In the ideas thus deeply implanted, the men who in the seventeenth and eighteenth centuries struggled against this mass of folly and cruelty found the worst barrier to right reason.*

So was the treatment of demoniacs developed by theology; and such was the practice enforced by ecclesiasticism for more than a thousand years.

How an atmosphere was spread in which this belief began to dissolve away, how its main foundations were undermined by science, and how there gradually came in a reign of humanity, will be related in the next chapter.

* As to the grotesques in mediæval churches, the writer of this article, in visiting the town church of Wittenberg, noticed just opposite the pulpit where Luther so often preached, a very spirited figure of an imp peering out upon the congregation. One can but suspect that this mediæval survival frequently suggested Luther's favorite topic during his sermons.

PHYSICAL TRAINING OF YOUNG CHILDREN.

By M. FERNAN LAGRANGE.

IT would be a great mistake to apply, in the physical training of children, the same principles as those by which gymnastics for adults is adapted. And as we recognize different grades in the intellectual teaching of children, corresponding with their different ages, so the exercises prescribed for them should vary, to correspond with the different degrees of their bodily development. The child's gymnastics should be quite distinct from that which is considered best suited to mature age. It should not look to utility, but should serve an exclusively hygienic end. The first object should be to give good carriage, to aid the pupils in reaching a full maximum of growth, and see that they are developed regularly, without deformity and without blemishes. All these conditions are within the domain of hygiene. A second feature of the exercise adapted to children regards the cerebral conditions which result from their being at school. They require diversion from the mental work that is put upon them, and such diversion can be obtained only by giving them the pleasure of recreation.

Hence, we have the two essential features that should be secured in infant gymnastics—the hygienic and the recreative.

The usual school gymnastics lacks much of being irreproachable from the hygienic point of view. Some of the methods seem to have been chosen rather because they were convenient of application than on account of any hygienic value. They are not adapted so much to the requirements of the child as to the accommodations of the school premises. Methods have been sought by which they could be applied in narrow spaces, and considerable muscular effort called out in a very short time. It may be convenient to collect a class of children once or twice a week and make them perform vigorous movements, but it is hardly what their hygiene demands. To measure out approximately the amount of exercise that ought to be taken in a week and administer it all at once is no more valid than it would be to give food for several days at a single meal. The child's exercise should be as carefully allotted to him as his food, and excessive fatigue as sedulously avoided as indigestion. A system of giving gymnastic exercises at too long intervals involves the dilemma that too great exertion may be called out at each lesson, or, if the labor is moderated, too little will be done. The child does not want intense effort at rare intervals, but moderate exercises frequently repeated.

The fact that intense muscular effort interferes with the development of the growing infant in height is perhaps less well known to hygienists and physicians than to veterinary surgeons and trainers. It has long been observed that young horses which are put to work too early never become as large as their fellow-colts which are allowed to reach their full growth in the pasture. Gymnastic apparatus, with the efforts which they necessitate, would have on the child the same dwarfing influence as harnessing to the wagon or the plow upon the colt. The infant prodigies of the circus sufficiently exemplify this fact. With all the skill they display, they seldom exhibit well-grown, evenly developed forms, but are usually in some way distorted; and persons who have begun hard work on farms or as laborers too early in life are generally stunted. Besides being unevenly distributed in time, these exercises are badly localized as to the different parts of the body. All exercises with fixed apparatus—the trapeze, the stationary bar, rings, parallel bars, slack rope, etc.—throw the work wholly upon the upper part of the body, leaving the muscles of the pelvis and lower limbs comparatively inactive. This is not so much matter with city men, who have to walk a great deal; but is a very important consideration with children at school, who spend most of their time sitting on benches.

In children muscular effort should be generalized, so as to make as great a number of muscles as possible participate in it, or at least to distribute it judiciously among the stronger muscles. When each group of muscles shares in the exercise according to its strength, the labor is less fatiguing, and we are able to obtain the general benefit of exercise—which is the communication of the highest activity of the circulation and respiration, without incurring the harmful results which are forms of fatigue. This benefit is more conveniently obtained through exercise of the legs than of the arms, because they are stronger and can bear more work without fatigue. In such exercises, of which running is the type, not only the legs but the pelvis, the vertebral column, the shoulders, and the arms, all participate. Exercises in which the work is localized, however much they may contribute to the development of the active part in the adult, do not have that effect in children, the volume of whose muscles is never increased by them. They are consequently useless, while they promote fatigue. They are liable to the further objection that they tend to produce deformities in young children subjected to them, whose plastic frames at their tender age yield very readily to any stress which is put upon them, and acquire a permanent set if it is repeated too often. Partisans of gymnastics plead, in answer to this objection, that their system may be and is used to correct bodily deformities; but the plea really strengthens the argument against the system, for the same structure that yields to a corrective application of gymnastic exercise will yield as readily to a distorting one. It is only when the frame has become mature and firmly set that such exercises can be applied without danger and to advantage; and that they are then useful when rightly applied can not be gainsaid.

These objections do not lie against floor exercises, or light gymnastics, which are not performed with fixed apparatus. In these, the child bends, stretches, and shifts his arms, legs, head, and body in various directions, at the command of the teacher, in measured rhythm. These motions are hygienically irreproachable. They do not exact any very intense muscular effort, or vicious attitude of the body, or abnormal use of the limbs. But even when performed in concert they are not recreations, and this is an extremely important matter with pupils whose brains are working to excess. They become exceedingly monotonous, and the child begins to perform them reluctantly, or learns to partly evade them. Although he can hardly escape going through the visible motion, he can easily avoid the muscular effort without which it is ineffective. The evasion may, it is true, be corrected by strict vigilance on the part of the teacher; but what becomes then of the distraction, of the mental relaxation which the pupil ought to find in his physical training? To compel one to the performance of the motions is no way to make him love his exercise. In this way the pupil finds in them, not a recreation, but a lesson additional to the others—a new burden. Now, recreation is not only a moral want of the child, but it is an important physical need, in so far as it furnishes a remedy for the nervous weakness and irritability that are induced by constant constraint, and helps to prevent disturbance of the equilibrium of the vital functions. Both of the gymnastic systems of physical education, therefore, lack the important essentials of being hygienic and recreative.

The prime fault of both these kinds of gymnastic exercise is that they are artificial. They were introduced for the praiseworthy purpose of supplying the want of natural exercise where that could not be obtained; but they have gone beyond this, and the notion has arisen that a child can not take proper exercise without going through an apprenticeship and being subjected to a method: the more complicated the method, and the more difficult the apprenticeship, the better the results that are anticipated. The elaborate gymnastics, which many regard as a kind of perfection of natural exercise, is, from the hygienic point of view, nothing but a make-shift when we can get no better means, but a poor substitute for the spontaneous gymnastics to which every child is naturally inclined. This instinctive exercise would amply suffice for the development of the body if the instinct was listened to every time it speaks, but social and scholar conditions do not permit this. The instinctive desire, repressed too often, becomes weakened, and finally disappears. The body accommodates itself to a sedentary life, and the insufficiency of exercise finally induces muscular indolence and an inert habit. The teacher of gymnastics would not be needed if the pupil had the privilege every day, for a sufficient time, of a large space, and liberty to amuse himself in it.

Why, then, erect halls and apparatus if we can have the privilege of a spacious sward or a garden with broad walks? While gymnastic apparatus may be useful where there is not room to provide other means, what is to be said of heads of families having ample spaces in the country, with all desired conditions for natural gymnastics, who go to the trouble of constructing gymnasiums for their children? The tendency to look for the best misses its mark nowhere more sadly than in the physical education of the child, when it prefers complicated processes to natural methods, and neglects the best hygienic means as too simple or insufficient. In the belief that the child can not take proper exercise without apparatus, when no apparatus is at hand no exercise is taken. He must have a special master for the exercise, and his taking it is made to depend on the master—to such an extent, that no one in the family thinks of the child's doing anything outside of the regulation lessons.

Instinctive gymnastics is, from the hygienic point of view, the best adapted to the regular development of the child. It is not liable to any of the objections we have brought against gymnastics with apparatus. It can not deform the body, for it is made up of spontaneous movements, and conformed to the natural office of each limb. It does not localize the work in a particular region of the body, for all the limbs are instinctively invited to take their quota of exercise; and it does not seduce the child into efforts touching upon the limits of his strength. Instinct also invites him to the kind of work which is best adapted to his particular aptitudes for resisting fatigue. He has a natural disposition to perform light but frequently recurring acts, quick motions, which put him out of breath, while exercises with apparatus rather exact slow and intense efforts that bring on local fatigue. Now, all observers have noticed the wonderful facility with which a child recovers his breath, and his impatience of local fatigue. Finally, natural exercise, being the satisfaction of a want, is by that very fact a pleasure; and joy shines in the face of the child who is playing freely.

The partisans of artificial gymnastics object to this method that it does not give in mature age the great muscular force, the capacity to bear fatigue, and the refined dexterity of movements—the various athletic and acrobatic qualities, in short, that should result from a complete physical education; and they assume that these superior qualities of the picked man, to be given the fullest vigor, should be cultivated from a tender age. They fall into the mistake, which is too often made in physical education, of not distinguishing between methods of development and perfecting processes. The physical education of the child, up to his fifteenth year, should have for its sole object to favor the growth of the body in all directions, particularly in height and weight; the perfecting of the structure of the organs, and the training of them by methodical exercise to a more complete performance, should come later on. The fourteenth year will be early enough to begin more energetic motions for hardening the flesh and developing the muscles. Till that age, physical education should especially aim to remove from the child all influences that may be in the way of the free expansion and growth of the body. Among these harmful influences are two of opposite character that produce nearly identical results—want of exercise, which makes the child emaciated, and excess of work, which stunts him.

This important distinction between developing and perfecting hygiene is well understood and observed by horse-trainers. They give colts nourishing food, free air, and room to gambol; and do not begin training them for work till they have acquired bodily growth and substance.

If natural gymnastics is enough for the animal, we may conclude from analogy that it would be amply sufficient for the child, if he had the conditions of space and time that are indispensable to the satisfaction of the instinct that impels him to exercise. When, then, the social conditions to which the child is subjected do not permit him to indulge in instinctive exercise, gymnastic methods as like as possible to those which instinct suggests should be sought for him.

The form of exercise that comes nearest to natural exercise is playing. It is nothing else than a more or less methodical regulation of the instinctive motions, such as every living being is prone to execute spontaneously when he feels the stress of the want of exercise. It may be called a natural exercise, for we see the young of every species of animals playing with one another, and may even observe their parents inciting them to play. The teaching of plays, which we find in all countries and ages, originates, we may suppose, in this tendency of the living being to educate his progeny physically by exciting him to enjoy himself in motion. Play, in the progress of civilization, has taken various forms, and has been subjected to methods that tend more and more to introduce into it an artificial element. Hence, sport has been developed from plays; the exercises called sports are in general simply plays that have taken a more methodical form, permitting a greater display of muscular force, exacting more complicated motions and a longer apprenticeship. It is sometimes hard to draw a clear line between sport and play. Fencing, equitation, and canoeing are varieties of sport. Cricket is as much a play for children as an exercise of sport; in short, in the hygienic view, sports are half-way between gymnastics and play, and are therefore more suitable to youth than to children.

Plays give the form of gymnastics most congenial to the conditions of social life, for they are at the same time hygienic and recreative, and are as well adapted to the physical requirements of the child as to his moral needs. Physically regarded, they demand neither very intense efforts nor localized muscular contractions. Even the most complicated of them call out nothing more than combinations of simple movements and natural attitudes; while gymnastics necessitates abnormal combinations in the association of the muscles, with movements which the child, having never practiced, has to learn laboriously. Play presents no difficulties comparable to those offered by gymnastics. If the child has not yet become adept in the game, he will play badly and lose his part; but he will play, and will at least gain the physical advantages of exercise. But when he is dealing with the abnormal motions or "turns" of gymnastics, if he has not yet learned the way of executing them, or acquired the knack, which it often takes a long time to gain, he only makes a pretense of exercising, and his effort is limited to a fruitless tentative, without any effective activity.

Besides the support of reason and observation, the method of exercise by playing has the sanction of acquired facts. It was the only children's gymnastics at the beginning of this century, and even now some nations have no other settled method of physical exercise. The English have never taken to gymnastics with apparatus; and the Belgians, after having tried it, are abandoning it and returning to play. No one can question the excellence of the results of the English method; the vigor and endurance of English youth are universally recognized, and their school-games constitute their whole gymnastics.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

The subject of mental overwork was discussed in the Anthropological Society some time ago, in the light of the recorded observations of school-teachers. Weariness of mind, it was said, is marked by irritability, as manifested in sleeplessness and in nervous laughter; and by fatigue, exhibiting itself in sleepiness and incapacity for task-work. Headache suggests overstrain in study, defective ventilation, or, perhaps, a too sparing diet. Sometimes the perception of particular colors is obliterated for a time, and this may suggest an explanation of some forms of color-blindness. In some cases a form of somnambulism was originated.

THE POLITICAL CONTROL OF RAILWAYS: IS IT CONFISCATION?

By APPLETON MORGAN.

IT may be doubted whether the non-enforcement of the Interstate Commerce law, however fortunate for the railway companies, is not an unmixed calamity for the country. For, if the shortest way to abolish a bad law is to vigorously enforce it, the danger is that the slumber of so un-American and unconstitutional a measure will lead, by mere lapse of time, to its becoming an apparent part of our governmental policy, and so, at the last, all the more awkward to be got rid of. Had the principle of the interstate commerce law been applied by Congress to any other industry or industries than that of transportation, it is exceedingly doubtful if the industries so paternally favored would have acquiesced as patiently and good-naturedly as have the railway companies. But there is no knowing how far the precedent may be pushed. So long as consumers outnumber producers and purchasers outnumber sellers, if the temptation should ever arise for the consumers and purchasers to decree the price at which producers shall produce and sellers sell (that is to say, for the majority to confiscate the property of the minority), certainly the principle of the interstate commerce law could be cited in favor of such a confiscation. (The railway companies in at least one of our Western States have been enjoying this sort of confiscation, under what has been called "the Iowa idea," viz., that "railways can take care of themselves," in abject silence now for many years, thus affording another cumulative precedent for a possible majority programme.)

When Judge Nelson set aside the verdict of a jury, on the ground that it "took thirteen men to rob a corporation in that court," he was entertaining a sort of judicial cognizance of that disposition on the part of the average "jury of the vicinage" toward railway companies which, unchecked, would quite speedily make railway operating a very costly amusement for investors. But the utmost juries can do toward robbing or crippling railway corporations is a very small matter compared with this latest movement of political forces, to confiscate—under the pretext of caring for—the interests of the people, of which the laws we are about to glance at are the outcome. Every sovereign State in this Union has constituted a "Board of Railway Commissioners," which is, and must be, political in its character, and so shifting with the politics of the State and of its Executive; and to these boards is relegated the whole procedure of the railway companies, and upon them is made incumbent and peremptory the duty of "regulating" the affairs of the railways. What is, and what must be, the result? The average politician knows fully as little or as much about railway management as he does about photographing the moon or applying the solar spectrum; yet, once upon a board of railway commissioners, he is required to excogitate and frame rules for an industry which not only supplies the financial arteries of a continent, but holds the lives as well as the credits of its citizens dependent upon the click of a telegraph or the angle of a semaphore—an industry which adjusts at once the most volatile and the most ponderous forces of nature to every necessary or luxurious service of our people! And, since thirty-eight boards of these accomplished commissioners were not enough, the General Government has kindly added another—not to regulate or supervise these thirty-eight, but to act in independent chaos to their tergiversations, and to contribute to the general value of their independent conclusions, ordinances, rules, and codes. What must, or rather what must not, be the result, when the country asks, as it appears to be now asking, to be furnished with railway experts and traffic accountants at the polls?

When the socialist programme shall be carried out to its full, it is understood that there is to be no inequality between the capitalist and the tramp. This equality, however, need not wait the perfection of that programme. It can be achieved to-day by two extremely simple methods. Either the tramp can go to work, earn money, economize, and become a capitalist, or the capitalist can divide with the tramp. But while the capitalist, for his part, opposes no objection to the first plan, the latter appears to be the only one the tramp will listen to. Both seem to be at present in abeyance. But, as to those aggregations of operated capital we call railway companies, I am not so sure but that the entering wedge for the second plan has been inserted. Let us see.

The interstate commerce act, with its administrative commission, does its fine work by forbidding two things; namely, "pools" and "discriminations." The State acts, with their administrative boards, also deny these two, but add edicts as to almost everything else: charges for service, size and cost of equipments, ratio of salaries, etc., to be charged, made or paid by their pupils the railway companies. I shall attempt in this paper to show that all this tutelage can have but one logical and political outcome; and that outcome—confiscation! The terminal sounds harsh, extravagant, impossible! But let us lead up to it and see if it be either.

The word "discrimination" means almost everything, and can hardly be limited to anything definitive. If I invite one of my friends to dinner, I discriminate in his favor against any friend whom I do not invite to dinner. If, in company with several millions of my fellow-citizens, I vote for President Harrison, and President Harrison invites a man who has voted for him to dinner, and does not invite me, he discriminates against me—me, from whom his charter as President has come equally as from my fellow-citizen who dines at the White House when I do not. But, conceding, in the case of a railway company, that discrimination, otherwise innocent, may work hardship—and also conceding the jurisdiction of the people over the railway company it has chartered, to prevent hardship to themselves—have this Interstate Commission and these boards legislated against the hardship? Have they not rather expended their legislation against the thing which may or may not be a hardship, according to circumstances, and in so doing increased the hardship, to their own damage and expense, rather than ameliorated it?

I. The Interstate Act.—This act directs itself to forbid (*a*) discriminations and (*b*) pools. Now, an edict against either of these might mean something—might even, if qualified, be productive of good. But an edict against both is really nothing—can not possibly amount to anything—except either an increased hardship to all parties concerned, or else the usual affirmative to which two negatives invariably amount. If railway companies can neither discriminate nor come together for consultation and abolishment of discriminations, what is the result? Merely the result which would follow an attempt to abolish the mice in a pantry by first abolishing the cat which had been put into the pantry to abolish the mice.

The only possible pretext on which Congress, acting for the people, could abolish pools, was that a pool was a "corner" in transportation, by which two or more competing lines proposed to raise the carrying-tariff in their section of country. But, as a matter of fact, the pooling system was a contrivance *to reduce jointly* the carrying-tariff in territory where two or more lines served, and that pooling system practically and actually did reduce the tariffs to shippers. This I have demonstrated and proved by figures already in the pages of "The Popular Science Monthly."* "The pool" proper had nothing to do with this reduction, except that it controlled the division of tariff receipts between the treasuries of the two or more pooling roads by a process of exact and expert differentiation in which a question of distance transported was only the very minor factor employed; such items as the cost of stopping, loading, or siding, or returning a freight-car empty to its owner, station expenses, repairs to track-way, rolling-stock, clerk-hire, improbability of find-

* June, 1887, p. 147.

ing load at small stations, fuel, grade, volume of traffic, cost of domestic goods at terminals as against direct importations from convenient ports of entry, rates of exchange, markets, first cost of plant, location and construction of track—and a few thousand other such items (an array which tends to make the practical railroad man's head swim by the very enumeration, but which are of no consequence whatever—are but the crackling of thorns under a pot—to the politician who represents his "district" in the Legislature or in the lobby), went into the consideration of the question of division of tariff receipts before the pool commissioner. (We may pause to ask, if reasonable rates were charged the public for transportation by a pooling road, what concern was it of the public's how the rates were divided when received? If I go into Delmonico's and pay a dollar for my luncheon, and on the way out stop at the cigar-stand and pay a quarter of a dollar for a cigar, what business is it of mine how the two cashiers I have paid equate the two payments—whether they turn them in as cash or merchandise, or itemized, or as items, or as receipts?) The public were not interested in the book-keeping methods of our railway companies. They were, however, very deeply interested in the cheapening of railway tariffs; and when, on the abolition of the pool, rate wars began again and tariffs advanced until—up to the first day of July the people had paid about $60,000,000 to the companies in excess of railway tariffs of the year before the interstate commerce law began to protect them against railway despotism—the people then began to look about for a possible cause. That cause was not far to seek. The railways, unable to meet and settle their differences in convention, where each should discuss its own problems and average them with the others, were forced to prepare each its own schedules independently. These separate schedule-tariffs were enforced and collected, and the Interstate Commerce Commission was able to say triumphantly, in its first annual report, that the act had operated directly to increase railroad earnings* in eight months from the approval of the act.

Why should it not have so operated? It could not have operated otherwise. That a carrier's rates should be "reasonable" had and has been common law for four hundred years, and by repronouncing it the interstate commerce law added nothing to its force. But to be "reasonable" a carrier's rate must not be unfair to either party. If it is unfair to the carrier—if it demands that he perform services for less by way of remuneration than it costs him to do the work—then the rate is certainly not "reasonable." And so it comes about that, by declaring in one paragraph that rates should be "reasonable" and in another that there should be

* Official edition, p. 41.

no "pool," the act did not prevent but rather conserved unreasonableness; for—since a "pool" was not a "corner," but an attempt, by co-operation and convention of railway companies, to make rates "reasonable"—a law which does not give the railways a schedule itself, and forbids them to come together to make one, simply means that each company shall make its rates without consulting anybody but themselves: must work in the dark, independent of any considerations except its own local, presumptive, or past experiences, frictions, and financial difficulties. Railways must not only make bricks without straw, but make them at their peril; for if, upon being made, these rates prove to be discriminate—that is not absolutely perfect and uniform between individuals—then the Interstate Commerce Commission (and nobody knows when it may wake up and commence operations) can send the officers to jail and hold the road in breach of law. Clearly the only safe alternative for the road is either to wind up business at once, or do business at a loss and pass a dividend to get even, thereby placing its securities at the mercy of the wrecker and the stock-jobber!

It follows from the above that the interstate commerce law operates, if operated at all, to create rather than to abolish "discrimination." But let us be a little more explicit. If all the people in the United States were shippers over one railway, a law that no one person shall be given a better or worse rate than another might possibly prevent injustice (though, unless it also provided that the volume of business or the length of the haul be taken into account, it may well enough be questioned whether it would or not). Even the non-railway intellect must absorb such self-evident propositions as that it costs as much to load, unload, or stop a car that has run two miles as one that has run two hundred; that if the car must be returned without a load, it has not earned as much as if it had found a load back; that a long haul, with but one loading and one unloading, one stoppage, and a return cargo for the car, ought reasonably to be done for less than a short haul involving quite as much handling without a return load, and that a railroad company ought in all fairness to be allowed to give the shipper the benefit of the decreased expense to the company. But the interstate commerce law peremptorily tells the railroad company that it must not give this benefit to the shipper, under the pains and penalties of fine and imprisonment, in its pleasure, for contempt of court. But let us admit, for argument's sake, that a law providing that no shipper shall be charged more per pound than any other would prevent discrimination if all the shippers of freight in the United States shipped over a single road. Clearly, if they shipped, as these shippers do, not over one, but over some five hundred different roads, such a law would not prevent discrimination, but actually compel it. Let us say that a shipper in New York desires to send goods all-rail to Chicago, and that he has a choice of three all-rail routes (as a matter of fact he has a choice of thirteen, but we will use the lesser number). One of these all-rail routes runs by a right of way laid out some forty years ago, under the then existing systems of engineering, climbs heavy grades, crosses the Alleghany Mountains twice, and makes the trip about one thousand miles. A second, laid out some twenty years later, has better grades, but crosses the mountains only once. A third runs by almost a series of bee-lines, has a grade nowhere exceeding one per cent, and was constructed and capitalized at less than a fourth part of the accumulated capital and indebtedness of the other two. Now, left to themselves, can these three railways, with different amounts of fixed charges, interest, dividends, and operating expenses to pay annually, carry for the same tariffs at the same rates to the same points, and all pay expenses? Ought they, in justice to the investors, whose money built them (and who are portions of the people quite as much as are the shippers over the line or the members of State Legislatures), to make the same rates for equivalent services? From the standpoint of the gentleman who believes that railways should meet their fixed charges, and all other expenses—should pay their bills, that is to say, like ordinary mortals!—from this standpoint, I say, it would seem as if a difference in rates to Chicago, over these three all-rail lines, was inevitable. And so it was, up to the invention of the pooling system: each road made its own tariff-schedules independently, and naturally the tariff of each was different from that of the others. But, without supposing that they were committing a crime, and as yet unconvinced of sin, these three railways, let us say, came together, and determined to make a single rate to Chicago for all business received by each of the three lines; these receipts to be pooled and divided something upon the basis outlined above. Even had they proceeded upon a basis of the single actual receipts to each for solicited business, there could be no difference to the public either way; but they chose to consider the most complicated problem of a single tariff divided upon the items of expenditure, outlay, and cost described above. What resulted? Simply that there was (as the interstate commerce law says there shall be) *no discrimination*. But when the interstate commerce law, while keeping the word of promise to the ear by saying there should be *no discrimination*, broke it to the hope by saying there should be *no pool*, what resulted? Why, in the case of these three roads, a discrimination in favor of one third against two thirds! For, when each of these three roads makes its own tariff, of course, the road having the smallest fixed charges to pay makes the lowest rates. The dwellers along that line have the advantage of these low rates to which, of the other two railways, only one can approximate; while the third line must either go to the other extreme, or defraud the holders of its securities. Not to dilate unnecessarily upon the situation, the reader can see at once that prohibiting a long and short haul discrimination upon any one railway really increases discrimination to the whole people; and that, on the whole, the pooling system was the fairest system for the whole people, as well as for the railways, that could have been devised, for both shipper and investor: for the shipper, since it gave him all the benefits of cheap freights; and for the investor in railways, because it secured to the railway built under heavy capitalization, and laboring beneath huge operating expenses (but serving a territory as entitled as any other, *per se*, to transportation facilities), a fair return upon the wealth that had been lavished to build it.

The theory of the interstate commerce law was borrowed from Europe—from England and Germany; and, although there may be those who admit that whatever is good enough for England or Germany is good enough for the United States, it ought not to be forgotten that neither of these eminent nations possess railroad systems at all analogous to our own, or in the operation of which anything like the same problems or conditions arise. The existence of two, let alone five or six, parallel lines is not only unknown, but impossible, in either of those countries; and yet the promoters of the interstate commerce act in Congress, and apologists for it ever since, pointed and still point with pride to the fact that the provisions of the act can not be onerous, because their operation has been tested, without annihilating the railway interest, in England and in Germany! * As a matter of fact, there are several hundred other practical discrepancies between American and foreign railways; but it would swell this paper unduly to discuss them here, and the above-mentioned alone is enough to dispense with the plea that the interstate commerce act is a good one for this people because its tenor has worked well across the ocean. I might add, however, that, despotic as is the German Government—the government of blood and iron—over all private enterprise, at any rate it has never yet discriminated against the enterprise of its own subjects in favor of the schemes of national rivals. Doubtless it is unfair to charge to the framers of the interstate commerce act a desire to benefit Canadian railroads (notably the Canadian Pacific Railroad) at the expense of our own railways. That such has been the paramount unpatriotic effect of

* "Much of the language used in the most important sections" (in the act) "has a settled meaning, having been judicially construed either in this country or in England."—*Senator Cullom's Springfield speech.*

that act is merely a proof that its framers overlooked the consequences of their hastily advised and badly considered procedure: were betrayed into regarding the popular hostility to railways from a political rather than from a patriotic standpoint, and so into the folly of precipitating a hard and fast rule upon an industry as delicate in its adjustments as it is massive in its ramifications; an industry of whose operations no single act or necessity of our sixty millions of people is independent; a rule so hard and so fast that were it attempted to be enforced (as a possible anarchist or socialist administration might see fit to enforce it) it would plunge the entire commerce and credit of this continent into chaos in twenty-four hours! To express the consequences, were it once literally carried into effect, the performances of the typical bull in a china-shop would be a notoriously inadequate figure (removal of a cataract from a human eye with a butcher's cleaver, or oiling the works of a Jurgensen watch by boiling it in axle-grease, might possibly better express the summary viciousness of the process).

So much for the Federal railway statute. As to the railway statistics of the several States, they have been comparatively innocuous—not so much from desuetude as from the general incapacity of their administrators. On the whole, their operation has been more largely comedy than tragedy—as where the Board of Railway Commissioners of one State have enacted that upper berths in railway-sleepers shall not be made up before the lower ones;* that of another have found that if a railway-bridge had fallen before a train reached it, instead of after the train had passed upon it, it would have been safer for the train;† or that if a bridge had been known to be unsafe, a train would not have been run upon it at all.‡ But that even State railway laws may be dangerous, I may note two very recent examples. The Board of Railway Commissioners of Mississippi have recently been given increased powers; have now authority to specify the description and size of station-houses which railway companies must build, and the point and location at which they must stand; to require the building of union passenger depots where two or more railroads connect, and to allot expenses of the same between the two or more companies compelled to pay for erecting them. This, in all conscience, seems to be going far enough. But the Iowa Board of Railroad Commissioners went still further, and not only regulated the question of accommodations, but actually furnished the railway companies *with a schedule of the prices at which they must do the business* which the people bring to them: that is to say—for the terms are convertible—the prices which the people shall be

* Minnesota Board of Commissioners. † Illinois Board of Commissioners.

‡ Massachusetts Board of Commissioners.

allowed to pay the railways! It is precisely as if the Legislature of New York should provide upon what quality of paper, with what size of type, or color of ink "The Popular Science Monthly" should be printed and furnished to its readers, the Legislature meanwhile not assuming any of the expenses or responsibilities of the publication, paying any losses, troubling itself about any of the risks incident thereto, or even inquiring into the facts of its circulation, cost of manufacture, or pay-roll: for that the Mississippi board even made the slightest effort to inquire—or heard any testimony as to—the volume of business, fixed charges, earnings or operating expenses of the companies to whom it dictated disbursements, there never was the slightest idea or claim anywhere. Indeed, it was the very gist of the ruling in some of those wonderful "Granger" cases (so called), that any such items as the above were "too remote"; the railway company must do business under schedules furnished by the shippers in Legislature assembled. Would a single powerless individual on this continent submit to such legislation as that?

It is rather remarkable that, though the Interstate Commerce Commission has existed almost two years at Washington, the only decisions at all affecting the general railway situation should come from Federal judges holding remote circuits, and that both of these should contravene and ignore an extraordinary tribunal created by Congress to specially oversee railways, sitting at the capital itself. The first of these declared that a railroad company might remain upon the earth, even though it was compelled to charge more for a short than for a long haul; * while the other enjoins the Iowa Board of Railway Commissioners from dictating the tariffs at which certain trunk lines shall do business within the borders of that State.† Of this latter decision let us hope that it will do something to relieve the delicate adjustments of our railway systems from the lash of ward politics and unenlightened demagogy.

Of all the popular fallacies ever discussed, it seems to me that the one which invokes popular prejudice against railway companies has the least actual basis of merit to stand upon. As a positive fact, the railway is not only chartered by the people, but can only be operated for the people's convenience. In "The Popular Science Monthly" for May, 1888, I had occasion to allude to a certain voluminous denunciation of incorporated industries as rehabilitating the effete institution of feudalism, which appeared to be principally based upon the supposition that *feudalism* and *despotism* were convertible terms. As a matter of fact, feudalism was not by any manner of means a despotism *per se*, even though

* Deady, J., United States Circuit Court for Oregon.

† Brewer, J., central division of Southern District of Iowa.

obtaining at a date when all government was more or less despotic (and generally more than less). Neither did a feudal system ever decree the prices at which its vassals should yield their labor. Supposing a railway company to have been in operation in the days of feudal systems, can any one imagine a law compelling it to make charges irrespective of the services it rendered? And yet, in a late session of the House of Representatives at Washington, a bill was, I am informed, introduced to forbid a railway company from carrying oil in tanks at lesser rates than it charged for carrying oil in barrels! (It is immaterial that oil in tanks can be carried with very little handling, and at an expense of labor and material very little over that required to run empty cars, while to transport it in barrels requires much handling, care, and watchfulness. Nothing in the way of detail, it appears, is material when politicians assume to legislate concerning railway companies.) Indeed, our railway companies might well clamor for and welcome a return to feudal systems, if they consulted their own convenience—to say nothing of their fixed charges! Nor would a return be such a bad thing for the anarchist or the socialist from his own standpoint. For, under feudalism, the subject was not touched by the crown-taxes—the taxes for revenue, for war-making, for internal protection. The fathers of our common law, in tracing the origin of property to "title by occupancy" to the garden of Eden (which Adam, at least until different arrangements were made, owned because he occupied it)—to the times when King Ahab, despot as he was, dared not help himself to Naboth's vineyard until, by ruse or device, he had divested Naboth's title—never denied the general proprietary title to the earth's surface which Mr. Henry George has selected as the proper one. They simply set it aside as inconvenient. But, whatever elemental title human beings may have to the use of the earth's surface as human beings, the railway company holds its title to its right of way by both alienation and use. It has purchased, but can only enjoy, so long as it serves the public. It is a public trust for a public convenience only. From the moment it ceases to serve the public and the public convenience, its franchises, its titles, its real estates lapse; and every court in Christendom has so decreed and maintained. If Mr. George's system of common proprietorship in real property were law to-day, he could not divest a railway company so long as it performed its functions. And yet it is over this industry, chartered only for the public facility—and simply because under and by reason of the immense convenience of that facility it requires enormous capitalizations and creates immense debts—that the politician squats, and the anarchist howls, and the communist grinds his teeth.

Altogether, the railroad company seems to be in the position of Mr. Dow's Calvinist:

> "You can and you can't,
> You will and you won't;
> You'll be damned if you do,
> And be damned if you don't!"

Twoscore of boards, framed by consent of local politicians, shout: "You railways must operate your trains. You must incur such bills as we Railway and Interstate Commissioners impose upon you, and do just as we say in everything; but you can not collect for your services the wherewithal to pay bills, except at such figures as we see fit to permit you to make. We know nothing about railroading. We are only Republicans, or Democrats, or Prohibitionists, or Women's-Righters. But do as we say; and if, in the doing of it, you kill anybody, or maim anybody, or if we hear of any defaults in payment of fixed charges, look not to us for loving-kindness!" This was Portia's idea of mercy to poor Shylock. And let us admit, for argument's sake (or concede it as certain, for that matter), that the railway company is a Shylock, compelled by law to exact the last penny to which it is entitled. "Cut out your pound of flesh," says Portia; "the court awards it and the law doth give it. But if, in the cutting, you take more or less, by the estimation of a single hair, than just one pound, then your goods are confiscate and your life itself is forfeit to the state"—and in so saying, the divine Portia (who had already admitted that the Jew asked nothing but justice, and was entitled to judgment at every point in his favor) was a by no means unfair prototype of the modern American Legislature, which first charters railway companies to exercise certain and stated functions, and then exercises them itself, leaving to the unhappy railway companies nothing but the responsibility and the punishment for its own blunders. Under the circumstances, is it to be wondered at that, very recently, a certain worm did, in some sort, turn?—that a certain railway company in the distant West, on being commanded by the Iowa Board of Railway Commissioners to turn in to them a statement of the value of its plant, replied that its plant was worth considerably less than before the commissioners began to make rules and regulations; that it would continue to depreciate as long as the commissioners kept on making them; that any estimate as to the aforesaid value would be mere guess-work; and that the only certainty possible in the matter was that enough rules and regulations from the honorable commissioners would ultimately deprive railway plants in their jurisdiction of any value whatever!

There are a few things left which a railway company may do. It may, by a late decision of the Interstate Commission, issue as many "passes" as it pleases, provided they are not used.* But no railway company is to be allowed to escape an interstate character from any such pretext as that it operates entirely within a single State—the commission affirmatively holding that if any parcel, the ultimate destination of which is outside of the State in which it is shipped, is carried by a local road, that local road at once, and by the act of carrying that parcel, becomes an interstate railway.† This is Lord Coke's celebrated maxim, that it is the part of a good judge to enlarge his jurisdiction—with a vengeance!

GIANT REPTILES OF A PAST AGE.

By OTTO MEYER, Ph. D.

INDIANS of to-day, who are well acquainted with the history of their race, may often think with melancholy of the olden times, when their forefathers were the only masters of the country. Numerous and powerful tribes occupied the vast territory between two oceans, some hunting the deer in the forests of the East, others ruling supreme in the plains and mountains of the West. The white man was fighting hard for his existence in small settlements along the coast. But, whatever perfection in warfare and in the use of their weapons the Indians had acquired by the experience and practice of many generations, it was useless against the rising foe, who possessed and introduced entirely new arms and methods. And what is the result to-day? The majority of the tribes, and among them the most powerful ones, have been extinguished entirely; while others, sadly diminished in numbers, linger here and there, and the pale-face is met everywhere.

The same feelings of melancholy must enter the mind of an alligator of geological education, when, during a *siesta* in the sun, he thinks of the good old Mesozoic times and compares them with the pitiable present. "How beautiful were the Triassic and Jurassic periods, when numerous and powerful orders of reptiles were masters of the earth, when mosasaurus and other kings of the water were hunting the animals of the ocean, when gigantic dinosaurs reigned on the land, and pterodactyls populated the air! That parvenu, the mammal, was existing only in small species and struggling for an existence. But, alas! how is it now? Of

* Matter of Burlington and Missouri River Railway Company. It is remarkable that, of the millions of passes which four hundred railway companies find it necessary to issue in the course of their operations, the only case in which a pass has attracted the attention of the commission is one where the pass was never lifted.

† Bragg, J. Matter of Johnstown and Gloversville Railway Company, "First Annual Report of Interstate Commerce Commission," p. 126.

our nine orders of reptiles five have disappeared entirely, among them just the most powerful ones, and only four are still in existence. Lizards, turtles, snakes, and we crocodiles have found refuge wherever we could, and mammals are met everywhere. And how did they succeed in thus becoming rulers of the earth? Simply by introducing new-fashioned arms and methods, such as warm blood and developed brains; and the most thickened bone plates and largest spines of our ancestors proved to be useless in the new kind of warfare." So *Alligator Mississippiensis* may meditate, and as a furious Apache Indian surprises and kills a lonely white squatter, so the alligator may rush upon and seize a strolling mammalian dog or pig of the nearest plantation.

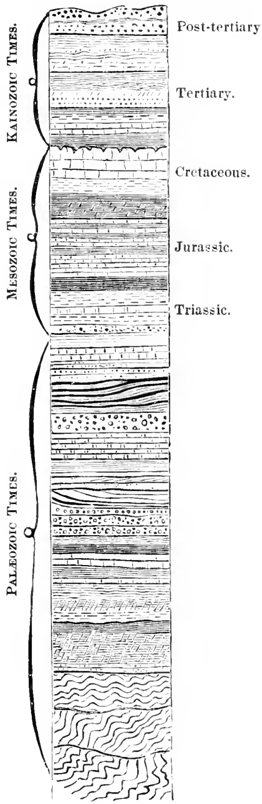


Fig. 1.

The dinosaurs, one of the mentioned extinct orders of reptiles, were animals living on the land, some of them peaceably feeding on plants, etc.; others were dangerous carnivores. In form and size they showed differences as considerable as are presented among the existing mammals by the elephant and the mouse. While the smallest known dinosaurs were not larger than a fox, some of them attained a size which is almost fabulous, and a giraffe or an elephant would appear as a dwarf in comparison with these monsters. We may obtain a general idea of many dinosaurs if we imagine an animal like a huge crocodile, but with a smaller head, a longer neck, and posterior legs which are larger than the fore-legs. These larger posterior limbs, in connection with the long strong tail, gave to these animals somewhat the appearance of a kangaroo. Like this latter quadruped, they were occasionally sitting on the hind-legs and the tail, and some of them were probably also walking or hopping on their posterior legs. Instead of starting from a crocodile, we might therefore say: Let us imagine a huge kangaroo, where the difference between fore and hind legs, however, is not so great, and then let us transfer this into the reptilian system. For, while a kangaroo is a warm-blooded mammal, covered with hair, the dinosaurs were cold-blooded, scaly reptiles. The anatomy of the dinosaurs resembles that of the lizards and crocodiles, but in many respects it reminds us of the skeleton of birds. These bird-like features appear especially in the pelvis and the posterior legs, and are so striking that some scientists believe that birds are the descendants of dinosaurs; others think that birds and dinosaurs originated from a common ancestor. The close relationship of these two classes of animals will appear to us more plausible if we remember the fact that the birds of the Jurassic and Cretaceous periods resembled reptiles much more than they do now—for instance, in their possession of teeth. This may be said of dinosaurs in general, and we may now contemplate some of their known representatives.

If we enter the Museum of the Academy of Natural Sciences in Philadelphia, the first thing that attracts our eye is an enormous skeleton found at the left side of the entrance. It represents an animal seventeen feet high, and measuring from head to tail twenty-four feet. It is mounted so that it stands on its hind-legs and is supported by its strong and long tail, while the short anterior limbs rest upon a structure purporting to be a reproduction of a tree of past periods. If we examine the skeleton more closely, we find that only a few bones of the hind-legs and the tail are naturally found fossils, while all the other bones are artificial casts. But most of them are exact representations of the original fossil bones, which are kept under glass for the sake of better preservation. They were found in 1858 in the cretaceous formation of New Jersey, and the animal has been described under the name of hadrosaurus. An exact imitation of this skeleton exists also in the National Museum at Washington.

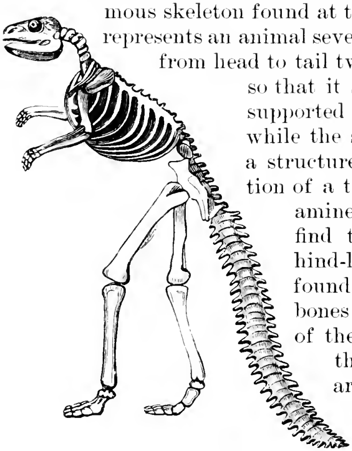


FIG. 2.—HADROSAURUS (restoration by Hawkins).

The hadrosaurus is as yet the only complete mounted dinosaur in America, and it must not be forgotten that some parts of this skeleton were not found, but for the sake of completeness were formed in analogy to the others. In Europe they have been more fortunate in this respect. In the Royal Museum, at Brussels, in Belgium, there is the mounted skeleton of a similar dinosaur, the anatomy of which is almost as well known as that of a dog or a cat. This animal, the iguanodon, in the way it is mounted, reaches a height of about fourteen feet, and a length of nearly thirty feet. It also stands on the hind-legs, and is supported by the strong tail, which constitutes about a third of the whole length. The neck is erect, and the head horizontal, as if the animal were gazing forward. The short anterior limbs, somewhat bent, are hanging down. The hind-foot is composed of three strong toes armed with claws. The fore-feet have a long and strong spine where we have the thumb. The name of the animal has been chosen on account of its teeth, which resemble remarkably those of the Brazilian lizard, iguana, and indicate that the iguanodon was no carnivore, but a herbivorous animal. It is thought that this animal lived in swamps or on the banks of rivers. It is further believed that it walked on its hind-legs, and that it treated its assailants in the way of a bear, by embracing them with its short and strong fore-legs, and piercing them by the dagger-like spines of the fore-feet.

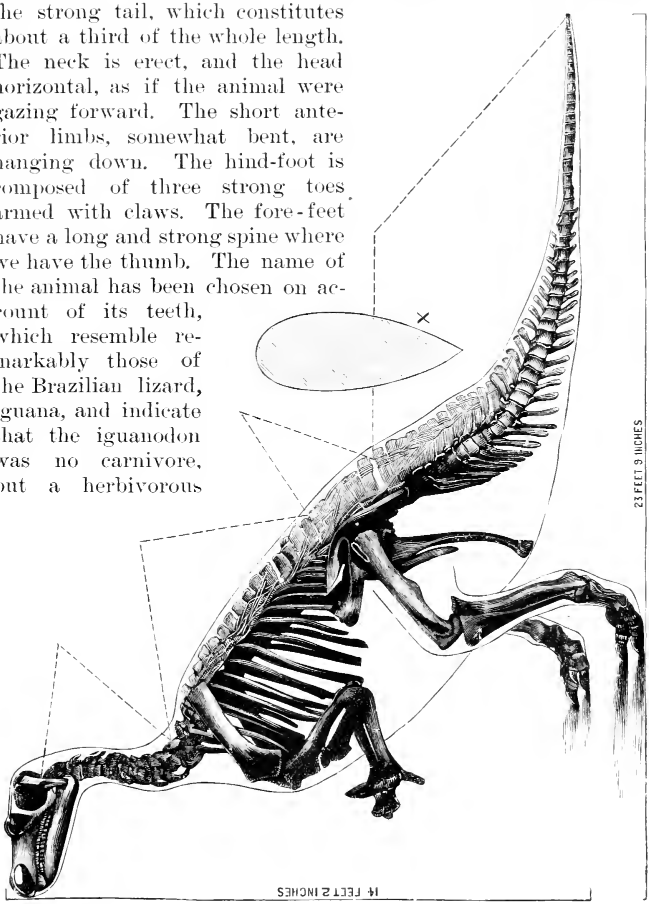


Fig. 3.—Iguanodon (restored and mounted by M. L. F. Depauw).

Who were these assailants? Probably also dinosaurs belonging to the carnivorous branch of this order. One of the best known of them is the megalosaurus, an animal of about the same size and way of living as the iguanodon, marching or wading mostly on its hind-legs. A carnivorous animal is characterized

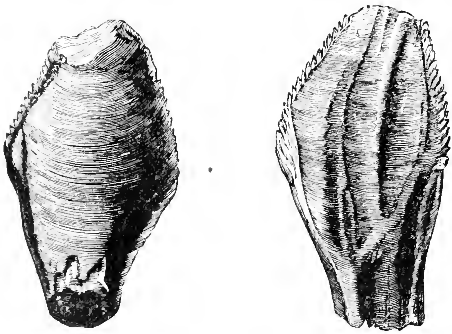


FIG. 4.—TEETH OF IGUANODON.

by its teeth, which must be apt to seize and lacerate its prey. The teeth of megalosaurus were few in number, large, flattened, of the shape of a saber, and with sharp, crenulated edges. Megalosaurus was a European dinosaur. One of the best-known American carnivorous dinosaurs of the Jurassic formation has been called ceratosaurus, on account of a large horn on the skull.

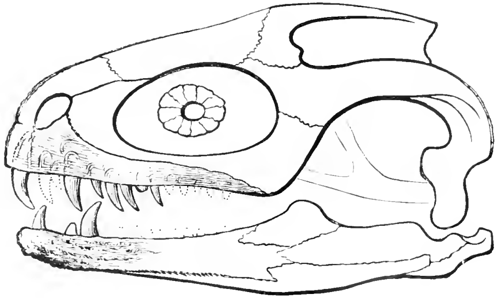


FIG. 5.—HEAD OF MEGALOSAURUS, one tenth natural size (restored by Phillips).

If the reptiles mentioned heretofore, with a length of twenty-five to thirty feet, must be called beasts of quite a respectable size, they were by no means the giants of their order. The largest known dinosaurs have been found in the Jurassic formation of the western slope of the Rocky Mountains, in Colorado and Wyoming. In the A Museum of Yale College, in New Haven, there are the vertebræ, limb-bones, etc., of the brontosaurus, which have been found in these beds. If, according to these remains, we make a restoration of the whole skeleton, the result is an animal of about sixty feet in length. But this is not all. The bone of the upper hind-leg, the femur, of the brontosaurus is smaller than six feet.

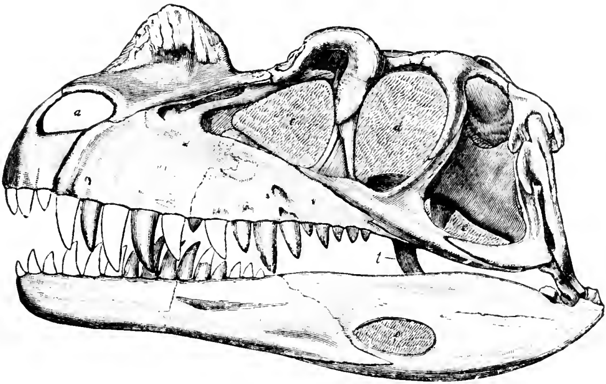


FIG. 6.—SKULL OF CERATOSAURUS, one seventh natural size.

But in the same museum there is, besides other remains, the femur of a very similar dinosaur, found in the same beds, which is about eight feet long, and belonged to an animal the length of which has been estimated at from eighty to a hundred feet. It has been called atlantosaurus, on account of its size. This atlantosaurus must have been a beast able to sweep down an elephant with a stroke of its tail as a crocodile would a dog. Of all the known land-animals, living or fossil ones, it is the largest, and it is probable that Nature reached a limit in producing land-animals of this size.

If we compare with the atlantosaurus the smallest known dinosaurs, we find an enormous difference. In the lithographic limestones of Solenhofen, in Bavaria, which have yielded so many well-preserved and interesting animals of the Jurassic formation, a dinosaur has also been found. This animal, called compsognathus, had posterior legs which were much longer than the anterior limbs. It therefore probably walked or hopped on its hind-legs like a kangaroo or a bird, and altogether, with its long neck and small head, must have resembled a good deal the birds of the same period.

The name of dinosaurs means terrible saurians (δεινός, *terrible*); and, indeed, the aspect of animals like the atlantosaurus and others was probably such as to justify this name. One of the oddest-looking creatures of this order must have been an animal called stegosaurus, the remains of which have also been found in the Western Jurassic and are preserved at the Yale College Museum. It was about twenty-five feet long. Its skull contained a brain which is comparatively the smallest brain which we know in any quadruped. It was, indeed, so small that it was probably not sufficient to control and direct all the nerves and muscles of the gigantic body. At any rate, we find in the stegosaurus that the vertebræ of the sacrum contain a cavity formed by an enlargement of the spinal canal. This chamber is ovate in form, and resembles the brain-case in the skull, but it is very much larger, being at least ten times the size of the cavity of the brain. Although we find in some animals a swelling of the spinal cord at the same place, there is nothing known which might be put beside the stegosaurus in this respect, and it is difficult to object if somebody claims that the animal possessed two brains—one in his skull and the other in his sacrum. The stegosaurus was, according to Marsh, protected and armed in the following way: At the region of the throat and lower part of the neck there were small dermal plates in the thick skin, which were regularly arranged. The upper part of the neck was shielded by larger plates of the same kind, which were placed in pairs on each side. These plates of bone increased in size posteriorly, and covered the back. From the sacrum

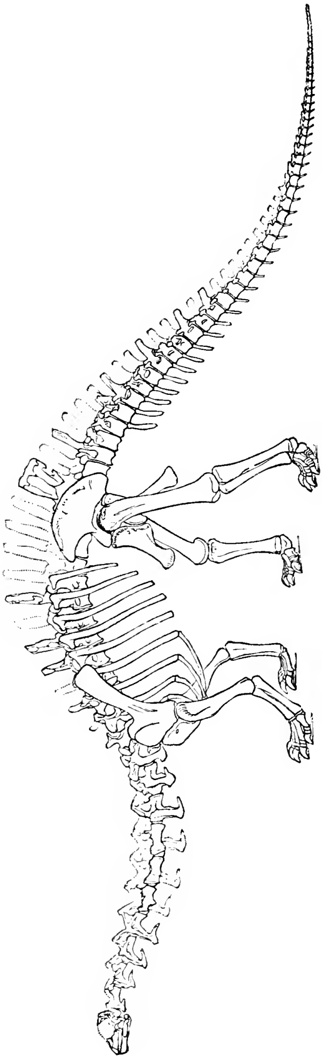


FIG. 7.—BRONTOSAURUS, one ninetieth natural size (restoration by Marsh).

to the middle of the tail there was only one row of large scutes. At the end of the tail there were, as weapons of offense, several thick spines, about a foot long, so that a stroke of this tail must have been telling in its effects.

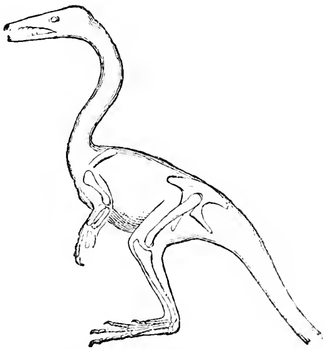


FIG. 8.—COMPSOGNATHUS (restoration by Huxley).

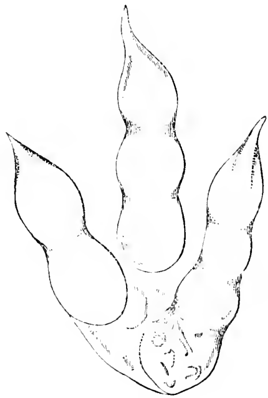


FIG. 9.—FOOT-PRINT OF BRONTOZOUM, one eighth natural size (after Hitchcock).

We have now made the acquaintance of several dinosaurs, yet they are by no means all the members of this numerous order, upon which already a whole literature has been published. Some of them are known only by their foot-prints. The Triassic sandstone of the Connecticut Valley contains numerous impressions of five-, four-, and three-toed dinosaurs, which at first were considered as the foot-prints of large birds. They were made when these animals walked on the muddy shores of the Triassic ocean. The collections of Amherst and Yale College contain each several thousands of such impressions—a fact that gives some idea of the abundance of reptilian life on the continent at that time. Also, in Europe, we find that reptiles, and among them especially dinosaurs, are the most numerous and dominating class of the Mesozoic times—that is, during the Trias, Jura, and Cretaceous; so that these times are often called the age of reptiles. At the end of the Cretaceous period, however, the reptiles decreased, and the dinosaurs became entirely extinct—at least, we do not know of any Tertiary dinosaur, and none exists at present.

Our knowledge of these remarkable animals is a comparatively recent one; of them almost nothing was known thirty years ago, but since then discoveries have followed each other in rapid succession, and every year contributes new data. It is especially to three American scientists that we owe most of our knowledge about dinosaurs; they are Prof. Joseph Leidy and Prof. E. D. Cope, in Philadelphia, and Prof. O. C. Marsh, in New Haven.

THE YEZIDEES, OR DEVIL-WORSHIPERS.

By DR. L. E. BROWSKI.

THE Yezidees, sometimes called "Devil-worshipers," are one of the half-dozen curious and interesting sects outside of Islam who live in Mesopotamia. But little is known of their inner life except to the initiated, for they resist all attempts to question them; and, when driven into a corner, will put off the inquirer with a fiction. The acceptation of these stories as true has been the origin of mistaken conceptions concerning them. Complete reservation of their religious precepts from strangers is one of their most binding obligations. To make secrecy more effective, the founder of the sect, Sheik Adi, decreed that only a single person at a time should be initiated into the mysteries, and designated as the person to whom the secret should be confided, the eldest heir of the tribe of Hassan el Bassri. Previous to his initiation this person is to be instructed in written Arabic, knowledge of which is forbidden to all others of the race, under penalty of death and loss of eternal salvation. The instruction takes place in a room from which all other persons are excluded. The text-book is the Koran, the only book obtainable in the country; but as this book contains many unflattering mentions of the devil, whose name no Yezidee must hear or pronounce or read, a friendly Christian is employed to procure the copy to be used and carefully cover all places where the devil is named with wax. If now by any accident the devil's name should be seen on the page during the studies, the book is shut at once, with an invocation, and thrown into the fire, and another one is procured. When the course of instruction is completed, the Koran is burned at once, because it is a wicked, blasphemous book, which should not be tolerated in the house of a Yezidee except under the sternest necessity. Instead of being devil-worshipers, as they are commonly called, the Yezidee religion is so fortunate as to have no devil.

By a most extraordinary accident the author obtained the sacred book of the Yezidees, whose place of concealment is known only to the single initiated, and was able to keep it long enough to copy it. Previous to entering upon the analysis of its contents, it will be proper to give a short account of the Yezidee people. They belong to the Kurdish race, and claim a population of three million souls. They are distributed in villages, residence in cities being forbidden, a few living in the provinces of Damascus, Aleppo, and Diarbekir, a greater number in the province of Mosul and the Russian district of Erivan. They are all subject, body and soul, to a chief who must be of the family of Sheik Adi, and who resides at Baadri, in the district of Shechan. He receives a considerable tribute from his people, and has in turn to keep up the temple and grave of Sheik Adi. The present chief is Myrza Bey, a son of Hussein Bey, who a few years ago died of drunkenness. He was the third of eight brothers, and had no right to the succession, but he formed a party and advanced claims. In the contest which followed, his elder brothers fell by his hand, and he thus made himself master of the situation. He then managed to make his peace with the Turkish Government, and was recognized by it. The Myr, as the chief is called, has supreme control of all the possessions of the Yezidees. To deny a wish expressed by him is to incur very unpleasant results in this world, and also to bring upon one's self the consequences of having offended the bodily descendant and representative on the earth of the great prophet Sheik Adi. All contests are settled at his tribunal, not by any fixed law, but according to his will and passing mood. Bloodshedding is atoned for by pecuniary indemnity; adulterous women are executed by their husbands without further proceedings. The Turkish Government is satisfied to receive its tribute, and lets the internal affairs of the people alone. It deals with the Myr, to a certain extent, as a state within a state. The Yezidees will not serve in the Turkish army, because their religion forbids them to mingle with the hated Mussulmans, but escape by paying a good round commutation fee yearly. The people are at the lowest stage of civilization, with no hope of rising so long as Sheik Adi's rules are in force. Under the influence of these conditions and of the prejudices of their neighbors against them, they have become a sinister, malicious, treacherous people. The rite of hospitality, so sacred among the Bedouins, is unknown to them. No one can feel safe among them. They attach no value to human life. To these ordinary dangers are added those arising from the embarrassing etiquette of conversational intercourse with them; for if any one inadvertently lets escape the word devil, Satan, or anything sounding like it, he commits a mortal offense; and to cut off his head is a God-pleasing act, and a sacred duty of the Yezidee, the fulfillment of which will insure him a place in paradise. Several letters are in like manner wholly banished from the language, chiefly those which contain the sound of a "shun"; also the Arabic word *nallet*, "Thou art damned," which was spoken by God to the fallen angel when he pitched him into hell. Therefore all words containing similar sounds are set aside, and other combinations not belonging to any language are used in their stead.

The Yezidees in the level regions of Shechan are quiet farmers and stock-raisers, paying their tribute to the Turkish Government without remonstrance; but on the Jebel Sindiia they are wild and indomitable, addicted to highway robbery, in constant antagonism with the Government, and often compelling the officers to use force in the collection of the taxes.

The great national sanctuary of the Yezidees is "Sheik Adi," the supposed burial-place of the founder and prophet of the religion. It was formerly a Chaldaic cloister, called Lalish, but was captured by the adherents of Sheik Adi, about the middle of the tenth century. It is in a beautiful valley, shaded with a rich vegetation, through which flows the sacred brook Semsen, coming down underground from Jerusalem, and here leaping from terrace to terrace. Every Yezidee is baptized and has his winding-sheet dipped into its holy waters, in order that he may be more sure of entering the paradise which Sheik Adi has promised him. Here resides the great sheik, who is next to the Myr, and whose blessing is good for the healing of diseases and for the assurance of a large posterity. The next place in the hierarchy is held by Mullah Haidar, a descendant of the learned Hassan el Bassri, and keeper of the book with the seven seals.

In one of the apartments of the temple are preserved the six sacred brazen images. They are roughly cast figures, in the shape of plumply developed cocks, one of which weighs more than seven hundred pounds, while the others are smaller. They are a gift from the dying prophet. There were originally seven of them, but one has been unaccountably lost. The holy book was also concealed for a time in Sheik Adi. This book was probably written in fairly good Arabic, at about the end of the tenth century, by Hassan el Bassri, Sheik Adi's disciple. It has existed since then in only a single copy, and is divided into two parts, of which the first contains the history of the creation, in occasional agreement with the Biblical narrative; and some account of the origin of the Yezidees and their subsequent fortunes, not always accurate, and containing many anachronisms. The second part —which is evidently to a considerable extent of later origin, for it shows various handwritings—explains the doctrines, precepts, and rites. The occurrence of Chaldaic words indicates that some Christian or ex-Christian priest or monk had something to do with its construction. According to this curious book, darkness prevailed before God created the heavens and the earth. He became tired of hovering over the water, and made a parrot, with which he amused himself for forty years. Then he became angry with the bird, and trampled it to death. The mountains and valleys arose out of its plumage, and the sky from its breath. God then went up, made the dry sky, and hung it to a hair of his head. In the same way hell was made. God then created six other gods out of his own essence, in the same way that a fire divides itself into several flames. These six gods are the sun, the moon, morning and evening twilight, the morning star, the other stars, and the seven planets. Each of them made himself a mare, with which to travel over the sky. The gods talk with one another in Kurdish, the speech of paradise, the language of languages. The seven gods together created the angels. It came to pass that the angel created by the first god rose against his lord, and was cast into hell for it. He at once set up a great lamentation, with confessions of his faults, and wept continually for seven thousand years, filling seven great earthen jars with his tears, till at last the all-good and merciful God had pity on him, and took him again into paradise. This angel afterward so excelled the others in doing good that God loved him more than all of them. The other angels once in a quarrel taunted him with his single sin and punishment. God overhearing this became very angry and said: "Whoever of you offends this little one with another word shall be accursed; whom God hath pardoned, the creature shall not make ashamed." He raised this angel to be first and master of all, called him Melek-Taus, and united him with his own person and existence, as two flames become one. The seven jars filled with the tears which he wept in hell are to be preserved till Sheik Adi shall return after having completed his mission on the earth, to be used in extinguishing the fires of hell.

The seventh god created the various species of animals, gradually, one out of the other, and finally Adam and Eve. But their posterity could not maintain themselves. After ten thousand years the earth destroyed them all, and then remained desolate for ten thousand years longer. Only the genii survived. The same thing happened five times again, each god creating a human pair in his turn. Finally the first god, with Melek-Taus, created the last first pair, Eve a considerable time after Adam, and not till after he had been expelled from paradise. Adam lived in paradise, and was allowed to eat of all the fruits growing there except of wheat.

In the course of time Melek-Taus said to God: "You have created Adam to people the earth; but he still lives in paradise, while the earth is uninhabited." God said: "You are right; take counsel about it." Melek-Taus went to Adam and moved him to eat of the forbidden fruit, upon which his expulsion from paradise followed as a punishment. God then determined to give Adam, who was still alone, a companion, and made Eve from his ribs, who bore him seventy-two pairs of twins. The Yezidees are not, however, descended from this race, but from a son miraculously given by God to Adam, named Shehid-ibn-Giarr, and a houri from paradise. Their posterity, the Yezidees, do not mingle with the children of Adam and Eve.

Shehid's eldest son was Yezdani, from whom, through his son

Noah, also called Melek Salim, the blessing passed to his grandson Marge Meran, the father of the Yezidee race. The Mussulmans are descended from Ham, who, having detected his mother in an intrigue, mocked her to his father. The children of Eve and of Ham hate the children of Yezdani, because they are the chosen people of Melek-Taus, who induced their father to eat the forbidden fruit, thereby forfeiting paradise.

The children of Eve laughed at Noah while he was building the ark in anticipation of the flood. When the ark struck on Mount Sindiar, it sprung a leak. The snake swelled itself up and stopped the hole with its tail; but after the flood, the snakes increased so fast as to do much harm to men. Noah was so vexed at this that he seized one of them and threw it into the fire. From its ashes arose fleas.

The history is continued, with a mixture of distorted incidents from the Old and New Testament accounts, the life and sufferings of Christ, stories of the Koran, and secular history. Christ, after suffering, but not actually dying, upon the cross, was taken by Melek-Taus into heaven, where, with him and God, he forms the Trinity.

Yezid, who made war upon his father, the Caliph Moanzeh, although he lived in reality a Mussulman, but unorthodox, is fabled in these books to have been a great champion of the religion of Sheik Adi, and to have possessed miraculous powers. He is said to have ordered all the books of Islam to be brought together and cast into the sea, and to have pronounced a curse of body and soul against every one, except those to whom special license might be given, who should thereafter read or write a letter of the Arabic language. Having overcome Hussim and Hassan, the sons of Ali, Yezid lived three hundred years at Damascus and then ascended to heaven. The Mohammedans obtaining possession of Damascus again, and beginning to oppress the faithful, Yezid was sent down to earth to protect them. This time he took the name of Sheik Adi. He again performed many wonderful works and effected some marvelous conversions, receiving the adhesion, among others, of the Caliph and of Hassan el Bassri, and drove the Christian monks from Lalish, where he established the seat of his religion. Jews, Christians, and Mohammedans, says the book of Sheik Adi, "curse and blaspheme in the way that they are led by their books. They are blind and hardened, and do not know that God comes down from heaven every thousand years and punishes blasphemers. They habitually speak of Satan, meaning thereby our holy Melek-Taus, who is one with God. This wicked name was invented by infamous and accursed people to shame our august protector. It is no less sinful to let words of similar meaning or like sound pass over the lips, such as *kaītan* (a sting), *shat* (the Tigris), *shed* (to bind), *nál* (horseshoe), and *lál* (a ruby). Whoever speaks one of these words is guilty of the most heinous blasphemy and deserves to die, and his soul shall be embodied in a mangy dog or a beast of burden. Therefore God forbids the reading of books, because such words are contained in them. Neither the Bible nor the Koran originally had these blasphemous passages, but they were added by evil-doers. It is also a great sin to eat salad, because its name (in Arabic) sounds like one of the titles of our saints."

The priestly order is hereditary, in the lines ordained by God, and includes, after the Myr, or high-priest, the Apiars, who reside at Sheik Adi, and dispose of their blessings for good money; the Meshaich, who, without having any particular ecclesiastical functions, pray for the healing of diseases and break the bread at marriage ceremonies; the Kovechek, who dance at the festivals and on other occasions; the Kavalin, who constitute the guard of honor to the seven holy images, make music, and attend to the collections; and the Fakirs, who are organized as begging-monks, and live wholly on alms. All these priests wear their beard and hair uncut, and can marry only within their class.

The Sanjak, or Holy Standard of the Yezidees, is asserted to have come down from King Solomon, having passed from him to the kings of their nation, and having been committed by Yezid to the Kavalin to care for. As among them, it is consigned to the one who will bid highest for the privileges and blessings attendant upon having it in possession. On stated occasions the Sanjak is carried around and exhibited to the people. The priest dips the standard into the holy water, and, taking some of the consecrated earth of Sheik Adi, makes of it pills as large as a hazel-nut, which he keeps as blessed gifts for the faithful. Whoever swallows one of these pills will be kept by the grace of Melek-Taus sound in mind and body for a whole year. The standard, preceded by a herald to announce its coming, is taken to the villages as they are designated by the Myr. The privilege of entertaining it having been sold at auction, the successful bidder makes a feast in its honor, which is attended by the priests in their order, and by the people, and, finally, the women and children. Offerings are brought and laid down, and at sunset all the faithful march seven times around the standard in honor of the seven gods, beating their breasts and asking pardon for their sins. When all the villages in the circuit have been visited, the standard and the collected offerings are brought to the temple.

Sheik Adi is the true Jerusalem, or center of the faith. At the beginning of the autumn the Myr and the Meshaich meet there in a cave and inquire of Melek, who appears to them, whether a festival will be agreeable to him. If the answer is favorable, the report is sent out, and in the course of twenty-three days thousands of Yezidees, with their wives and children, will have collected at Sheik Adi, bringing with them provision of a peculiar cake, for no kind of food must be prepared there during the pilgrimage. On the twenty-third day, the great Sheik comes out from the cave, takes his seat upon a stone, and salutes the people. Every person, thirty years of age and over, must bring an offering from his live-stock, according to his means. The Meshaich now come out of the cave and join the Emir on a high tribune, where, with the priests of the other orders, they form the Council of the Forty. An ox is stewed in a big kettle from morning till sundown, when at the call of the Emir a number of young men come up, and, plunging their bared arms into the hot mess, accompanied by ceremonial music, pull out the pieces of meat and distribute them among the Emir and the Council. The skin and flesh of the young men's arms may peel off to the bone, but those of them who die are at once enrolled among the saints; and in their honor the hunters of Sindiar and Chartie climb to the top of the mountain and loudly clash their shields together, or, more recently, fire volleys of musketry. This ceremony is called *kabaah*. Every one of the attendant faithful receives a share of the broth, making an offering equivalent to about a sixpence in return. After three days of the festival, the faithful are all baptized in the waters of the holy Semsen—a stream which issues from a cave into a broad, stone-lined basin—and after them the women and girls receive a dip. The water for drinking is taken from a pond into which the water flows from out of this basin. None can be drawn from the upper part of the source. Three of the holy images are ceremonially dipped in the brook, carefully dressed, and arranged around the Sanjak; each of the faithful takes a little of the sacred earth and presents his offering, and the festival is ended.

The religious ceremony of marriage consists in the couple going before the Sheik and eating a piece of bread which he has broken in two. A feast is given afterward, at which the attendants contribute toward a gift to the Myr, in commutation of his sovereign rights. Weddings are not celebrated in April, or on Wednesdays and Fridays. The relatives of a widow have a right to give her in marriage, whether she be willing or not, to the sixth time, after which she is at liberty; but, if she will pay the relatives as much as the new suitor offers, she discharges the account, and they have no further control over her. The marriage bond is dissoluble by death, by removal, by putting the wife away on account of transgression, and, without cause, after eighty years of it.

The priests claim the power to heal diseases through the interposition of the saints, and by the water of the brook Semsen and the earth of Sheik Adi. They say that Rejel-el-Senne occasionally sends his plague-soldiers to vex men; when they repent of their sins and confess them, the saints intervene to vanquish the pest-soldiers and drive them away.

The souls of deceased believers are supposed to go into paradise to dwell with the seven gods, Melek-Taus, and the saints. Sheik Adi is the door-keeper there. The souls of unbelievers and of sinful Yezidees go into the bodies of asses, mules, and dogs. Upon the death of a Yezidee, his mouth is at once filled with the holy earth of Sheik Adi. The body is buried under the direction of a sheik and the kavalin. The body having been laid in the grave, facing the east, some sheep's dung is scattered over it, and the grave is filled up with earth. The women mourn, sing dirges, beat their breasts, and tear their hair for three days; and, if a traveler comes along, he is entertained for the salvation of the soul of the deceased. The mourners and their friends afterward meet in the house of the deceased, where the Kovechek dance and sing to Melek-Taus till they look him in the face, when they are seized with convulsions, and fall senseless to the ground. This is a sign that the soul of the deceased has entered paradise. The whole winds up with a funeral feast.

If a man has an evil-disposed son, he secretly buries his wealth, so that it shall not be wasted after his death, and marks the spot with some sign. When he is born again, to lead a new life, as his religion teaches him is to be the case, he will go and recover his treasure.

New-year's-day is a great festival, and is always observed on the first Wednesday after the vernal equinox. On this day, God collects in paradise all the saints and their relatives, and sells the world's coming year at auction. The highest bidder is made Rejel-el-Senne, the ruler of the year, and has the direction of men's fates according to his will, and the distribution of plenty and happiness, want and disease. On the morning of the previous day the Kochek calls from his house, imploring from Melek-Taus blessing upon all who are within hearing of his voice. The young people then go to the mountains and woods to gather red shkek flowers with which to adorn the doors of their houses; for no house not thus ornamented can be secure from the afflictions of the year.

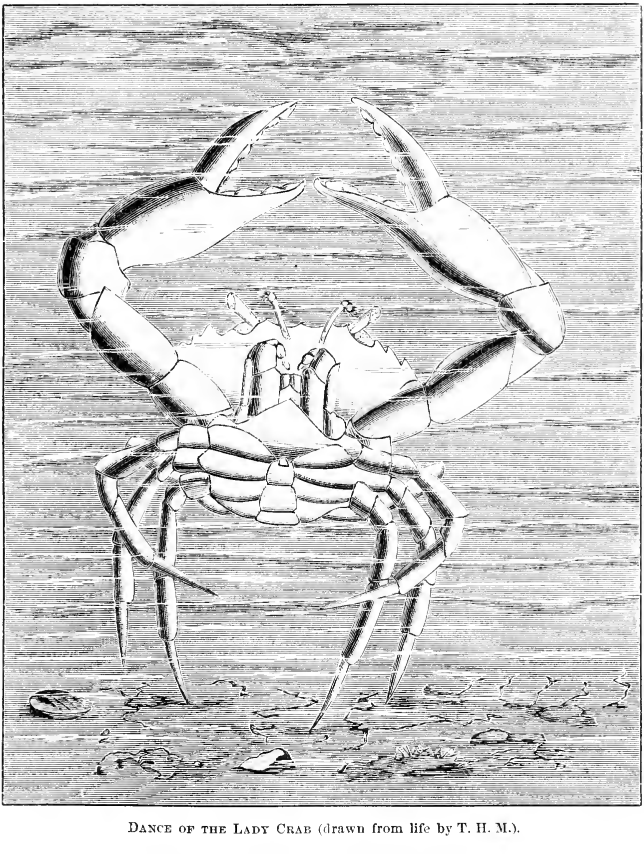
The legend of Sheik Adi's call to be a prophet relates that, as the holy man was riding over the fields one moonlight night, in his twentieth year, there suddenly appeared rising from the ground, in front of the tomb of Abu Rish, a vision of two camels having legs four cubits in length, with heads like those of buffaloes, hair long and bristly like a thorn-bush, large round eyes glistening with a greenish luster, jet-black skins, and other features like those of men. The tomb had become immensely large, and had taken the shape of a minaret towering into the clouds. It then began to shake, and Sheik Adi in his fright overturned a water-jar that was standing by his side; and the apparition, which had turned into the shape of a handsome boy with a peacock's tail, exhorted him: "Do not be afraid; the minaret, indeed, will fall and destroy the earth, but you and those who hear your word shall not be harmed, and shall rule over the ruins. I am Melek-Taus, and have chosen you to publish the religion of the truth over the earth." This said, he took Sheik Adi's spirit with him into heaven, where it stayed for seven years, receiving instruction in all truths, while the body of the saint remained asleep by the tomb of Abu Rish. When his soul returned to it from the sky, the water had not yet run out of the overturned jar. — *Translated for the Popular Science Monthly from Das Ausland.*

THE DANCE OF THE LADY CRAB.

By T. H. MORGAN.

ABOUT the 12th of September, 1888, there was brought into the laboratory of the United States Fish Commission a male specimen of the lady crab (*Platyonychus ocellatus*), which was placed in an aquarium with a female crab of the same species. During the evening of the 13th, while sketching some hermit-crabs which had previously been placed in the same tank, I was attracted by the movements of the male Platyonychus. Without apparent cause he was seen to rise upon the third and fourth pairs of legs; his large chelæ were thrown above his head with the claws open and their points touching in the middle line; his fifth pair of feet were held horizontally behind, and his body perpendicular to the floor of the aquarium, or at right angles to the normal position, as shown in the accompanying figure. The posture was ludicrous, and, when in this position he began slowly to gyrate, his movements and attitude were the cause of much merriment upon the part of the spectators. At times he balanced on two legs of one side, again on two legs of opposite sides. Now he advances slowly and majestically, and now he wheels in circles in the sand on the floor of the aquarium, and now for a few moments he stands as if transfixed in this unnatural position. An electric light hung above and to one side of the water, which suggested the possibility that it might be the exciting cause. It was turned out, and still the dance went on, and the joy was unconfined. At last, from sheer exhaustion, he sinks down to the sand in his usual attitude.

But now the female, who has all this time remained tucked away in the sand, comes forth and begins to move about the aquarium; soon she comes near to the male crab, when instantly he rises to his feet and begins to dance. Again and again the per-



Dance of the Lady Crab (drawn from life by T. H. M.).

formance is repeated, and each time the approach of the female is the signal for the male to rear high upon his hind-feet, and to reel about the aquarium as if intoxicated.

At times, when the female approached as he danced, he was seen to make attempts to inclose her in his great chelate arms, not with any violence, for the claws never snapped nor closed violently; but she was coy, however, and refused to be won by his advances, for the dance may have been nothing new to the lady crab, nor half as interesting as it was to the two spectators outside the water. Later, he too buried himself in the sand, and the performance came to an end.

The next day, and the day following it, the two crabs were watched, but without anything unusual taking place. The colors and markings of the male and female were much the same, though it seemed that the male had slightly more brilliant tints. To determine whether or not there is any marked sexual difference, a greater number of both sexes will have to be examined, and this at the time when the males woo the females under perfectly normal conditions.

Performances such as these are by no means uncommon among the vertebrates, especially with male birds in their endeavors to attract the female; but I believe there are few, if any, performances of this kind on record below the vertebrates.

To any one who has watched the crabs in their natural environments, the complex psychological development which may here be brought into play will not be surprising; yet, if the instinct which leads the male to dance is the same that we see in male birds, and if the female shows any discrimination between the dancers, the mental development must be considerable. Darwin has, in his "Sexual Selection," recorded among Crustacea many instances of difference in structure, and a few cases in which the color* of the two sexes is slightly different, but does not mention any performance comparable to the dance of the Platyonychus.

ON THE CAUSES OF VARIATION.†

By C. V. RILEY, Ph. D., United States Entomologist.

I.

WHATEVER influence we may attach to environment and external conditions, it is self-evident that they alone have not been sufficient to induce the wonderful variety of life existing upon the globe to-day. Indeed, so far as natural selection implies necessary utility, necessary adaptation to surroundings, it is, as I have said, defective. We know very well that introduced species from one continent to another, or from one country to another, have proved better adapted to the changed conditions

* Prof. Conn has reported a sexual difference in color in Callinectes.

† From the address of the Vice-President of Section F of the American Association for the Advancement of Science, delivered at the Cleveland meeting, August, 1888.

than the indigenes or endemic forms. This is readily comprehended on two grounds: First, that species which have, in the course of time, experienced a greater struggle among themselves in large areas, have an advantage over those in more limited areas in which the struggle has been less intense; secondly, that species which have accommodated themselves to the changes in life conditions which civilized man induces, have a great advantage when, following man's migrations, they are brought into competition with species which have not yet been subjected to such conditions. Again, no valid reason can be urged why, within a given area, one species predominates over another in so far as mere adaptation is concerned. The influences of environment alone would tend to unify the fauna and flora of a given region. Theoretically, so far as climate and physical conditions are concerned, there is no reason, through regions where these are uniform, why a single animal should not prevail to the exclusion of all others, providing it was vegetarian, or that the particular plant which furnished food to such an animal should not prevail to the exclusion of all others. The hickory and the blade of grass must be considered equally adapted to the environment with the oak, and so on all through the multifarious forms of both vegetal and animal life: so that this diversity of form can best be explained by some principle like natural selection, and by the interrelation and interaction of organisms and the struggle between them for existence. This is illustrated in many directions. To take a striking example: no one doubts that if the larger carnivora of Europe and Asia were introduced into Australia, the marsupials would soon have to give way, and could survive only by the acquisition of special functional modifications and larger intelligence such as we find in our opossum. Yet it would be folly to conclude that the marsupials are less well fitted to the physical conditions which obtain in Australia than their introduced exterminators.

From what has preceded, we are, I think, justified in rejecting the interpretations of both extremists as to the scope and meaning of natural selection. It can not be debased to the mere expression of the universally observed fact of variability; yet it must be restricted, because it not only implies something to be selected, but its promulgator limits its scope to the selection of something that is useful. As a philosophy it considers only processes, and leaves remote origin and cause untouched. The following limitations are probably justified to-day, and will help to more exact use of the term:

1. It deals only with individual variation from whatever cause, and should not be applied to simultaneous variation in masses.

2. It deals only with variations useful to the organism in its struggle for existence, and can exert no power in fixing the endless number of what, from present knowledge, we are obliged to consider fortuitous characters. It can not perpetuate useless organs; nor those of a vestigiary or obsolescent character.*

Even with these restrictions, the principle is far-reaching and profoundly important; but it quite fails to account for many of the most interesting manifestations of life that are obviously not necessary or life-preserving, of which many will occur to every one, such as, among lower organisms, many superficial details of structure; or, as among higher organisms, odd habits and customs, playful instincts, ethical traits, etc. Its limitations must be narrowed in proportion as we come to understand the other laws of modification and the causes of variation in masses. Let us briefly consider some of these causes.

We soon find that they admit of a certain amount of classification, the minor divisions of which, as in all systems of classification, more or less fully interlock or blend. They fall, however, into two chief categories, viz., (1) external conditions or environment, which are, at bottom, physical, and (2) internal tendencies or promptings, which are, at bottom, psychical. We shall also realize more fully that there is good reason for the varying importance which has been placed on natural selection because it represents a broad principle, based on the outcome of both these categories, but particularly of the latter. Its value is not a fixed one, and must needs change with the increase of exact knowledge of the other factors, and did in fact change in the mind of its originator. We shall further find that there are laws of evolution which permit of formulation and expression, and which have influenced or controlled the mode of variation, but which must not be confounded with or included among the causes of the variation proper, though here, again, the line between the two kinds of factors is not always easily defined.

The conditions of organic modification may, therefore, roughly be classed as (A) external and (B) internal, and these may be almost indefinitely subdivided. The former class includes (1) *physical* and (2) *chemical* forces, and in a broad way may be said to induce modification independently of natural selection, however much this may act with them as a secondary cause. Certain prominent features of the physical forces are worthy of mention: as light, temperature, water (stagnant, or in motion), climate (under which term may be included meteorologic phenomena, as electricity, atmospheric pressure, etc.), mechanics (gravitation, wind, stress, friction, etc.) and geographics (migration, isolation, etc.).

* In the literature of evolution, these are usually termed rudimentary, but, strictly speaking, this term should be applied only to nascent or incipient structures.

The chemical forces may be considered under the subdivisions aquatic, atmospheric, food, and soil. In class A may also be included (3) *vital** or organic force in so far as this is concerned with the interaction of organisms, and it is seen thus to link the two great classes. The second class (B) includes (1) *physiological* and (2) *psychical* forces. Prominent among the former, as causes of modification, are worthy of mention those connected with genesis itself: as heredity, physiological selection, sexual selection, hybridity, primogenital selection, and what I would call sexual differentiation, and philoprogeneity. Among the latter may be included use and disuse, individual effort, etc.; and last, but not least, the emotions.

Now, with the limited definition given to natural selection, all the forces in class A act independently of it, while the rest are more or less fully aids to its action. Time will not permit of much detailed consideration of the physical and chemical forces. Nor is such consideration necessary; for their influence, as Darwin well remarked, is obvious. Fundamentally, they must needs limit and control all manifestations of life, of which indeed, on evolutional grounds, they are the material basis. Change of physical environment may affect function first and chiefly, but this involves change of form and structure which are integrated by heredity. The surface of the earth and the waters upon it and the atmosphere above it have necessarily conditioned the chief modes of animal locomotion, as swimming, flying, crawling, and walking, while the five great classes of vertebrates find the explanation of their structure, as J. E. Steere pointed out at the Ann Arbor meeting, in the conditions of life in water, in shallows, in the air, on land, and on trees and rocks.

External Conditions.—By external conditions, or environment, we include all influences on organisms which act from without, and in carefully considering them we shall find it difficult to draw the line between those which are really external and independent of any motive or inherent tendency in the organism, and those which are not. Hence, the general term "external conditions" is resolvable into various minor factors. Considering the influences as a whole, we find that in the 1844 essay, or sketch, Darwin gave more weight to them as producing variations, and as modifying habit, than he did in the "Origin"; yet we all know that he felt convinced, when this work was first issued, that natural selection was the main, though not the exclusive, means of modification. Before his death, he was again led to attach greater

* I am well aware that this term is much tabooed among a certain class of the more materialistic evolutionists, but I use it here for want of a better, and because, as an expression of one form of manifestation of force, it has as much a classificatory value as physical or psychical.

importance to them. As late as March, 1877, he wrote to Neumayr, of Vienna, that "there can not be any doubt that species can be modified through the direct action of the environment. I have some cause for not having more strongly insisted on this head in my 'Origin of Species,' as most of the best facts have been observed since its publication." He was led to this modification of his views by Neumayr's essay on "Die Congerien," and by Hyatt's work in showing that similar forms may be derived from distinct lines of descent. In his correspondence with Huxley, Darwin remarks that one point has greatly troubled him. If, as he believed, accidental conditions produced little direct effect, "What the devil determined each particular variation? What makes the tuft of feathers come on the cock's head, or moss on the moss-rose?"

It is quite plain, indeed, that subsequent to the publication of the "Origin," and especially in 1862, in his correspondence with Lyell, Darwin was inclined to give more power to physical conditions, and, in fact, was wavering in his mind as to the force of the different influences at work. In his letters to Hooker, in 1862, the same tendency may be noted, and the preparation of the "Variation of Animals and Plants under Domestication" led him to believe rather more in the direct action of physical conditions, though he seemed to regret it because it lessened the glory of natural selection, and, to use his own language, "is so confoundedly doubtful." One can plainly trace from the correspondence how, prior to the publication of the "Origin," he more and more, as his facts accumulated, and as the theory of natural selection grew upon him, relegated to an inferior place the influence of environment; while, subsequent to the publication of that work, and up to the time of his death, the tendency seemed to be in the opposite direction.

Many eminent workers have differed greatly from Darwin in the influence allowed to these external conditions, and this is particularly the case with our American writers. Indeed, no one can well study organic life, especially in its lower manifestations, without being impressed with the great power of the environment. Joseph Le Conte speaks of the organic kingdom lying, as it were, "passive and plastic in the molding hands of the environment." Leidy, Wyman, Clark, Packard, etc., have insisted on the influence of physical conditions. Baird and Ridgway on geographical distribution, Whitman on concrescence, Hyatt on gravitation, Cope and Ryder on mechanical stress, have all published valuable corroborative evidence; while many other writers have added their views and testimony, which have been admirably condensed by Prof. Morse in two addresses before this association. Allen demonstrates plainly the influence of climate and temperature in directly inducing specific changes. Weismann, in his remarkable "Studien der Descendenz-Theorie," concludes that differences of specific value can originate only through the direct action of external conditions, and that allied species and genera, and even entire families, are modified in the same direction by similar external inducing causes. In Semper's "Animal Life" (1877) we have the best systematized effort to bring together the direct causes of variation, and no one who has read through its pages can doubt the direct modifying influences of nutrition, light, temperature, water at rest and in motion, atmosphere still or in motion, etc., or question his conclusion that no power which is able to act only as a selective and not as a transforming influence can ever be exclusively put forth as a *causa efficiens* of the phenomena. Kölliker, in 1872, wrote: "Manifold external conditions, when they operate on eggs undergoing their normal development, on larvæ or other early stages of animals, and on the adult forms, have produced in them partly progressive and partly regressive transformations"; and recognized as most important forces, nutrition, light, and heat. Indeed, the direct action of environment must have been, as Spencer puts it, "the primordial factor of organic evolution."

In so far as it offers evidence, entomology confirms the conclusions of the writers in other departments of natural history, above referred to, and offers a host of most conclusive proofs of the direct action of the physical and chemical factors which I have enumerated. Justice, however, could not be done to the facts within the limits of an address of this kind, and I pass on to some of the other factors.

It is among what I have called the vital or organic conditions of variation that natural selection has fullest sway, and, as they have been so ably expounded by Darwin and others, they may be dealt with in few words.

Interaction of Organisms.—The productions, as a whole, of greater areas will, whenever they get an opportunity, conquer those of lesser areas, and in this broad sense the interaction of organisms may be said to have had no special modifying power, however great its influence may have been, and is yet, in inducing the survival of the fittest, or in bringing about the present geographical distribution of species. The consequences of enforced migration and of isolation are best considered when dealing with the physical conditions, because they must influence modification of masses rather than of individuals, and either substitute one type for another or remove competing or differentiating influences. But, in the more restricted sense, i. e., the interaction of organisms occupying the same ground—the struggle for existence, in other words, between direct competing organisms—is a prime

Darwinian factor of modification, and a whole volume of illustrations may be drawn from entomology; for in no class is the contest more severe, whether with plants, or with other animals, or with one another, than in insects. In no other field of biology, for instance, have the physical conditions resulted in such infinite diversity of form and habit fitted, whether for earth, air, or water, and often for all in the same individual; so, also, in no other field is parasitism carried to such a degree, or are the purely adaptive structures due to this interaction so varied or so remarkable. The entomologist who goes beyond the "dry bones" of his science is inevitably a Darwinian.

In this category must also be included that interrelation between insects and plants which has eventuated in the so-called carnivorous plants, and that still more wonderful interaction between flowers and insects by which each has modified the other, and the facts of which have been so untiringly observed and so well set forth by a number of writers from Sprengel's day to this, and by none more successfully than by Darwin himself. These are plainly inexplicable on external conditions acting on masses alike, and are meaningless enigmas except on the theory of natural selection, or some supra-natural and dogmatic gospel.

We are thus led, through this last, from the external to the internal factors in evolution, or those of a physiological and psychical nature. In these, natural selection is the key which, so far, best unlocks their meaning, and shows how they have acted in the formation of species and the less fundamental of the great groups. In considering them it is hardly necessary to discuss their relative importance as compared with the external conditions, though it may be remarked that they are the factors which have induced the great variety of adaptive forms and minor differentiations, while the external conditions have governed the formation of the great and more comprehensive types of structure.

Darwin was led to give more importance toward the end than he had originally done to some of these internal factors, and especially to functionally produced modifications. In the "Descent of Man" he says that he did not sufficiently consider variations "which so far as we can at present judge are neither of benefit nor injurious; and this I believe to be one of the greatest oversights I have yet detected in my work." And in the sixth edition of the "Origin" he frankly admits that he had omitted in other editions to consider properly the frequency and importance of modifications due to spontaneous variability. He further refers to morphologic differences, which may have become constant through the nature of the organism and the surrounding conditions rather than through natural selection, since they do not affect the welfare of the species. In short, Darwin's views kept pace with the investigations of his day, and tended in the direction of restricting rather than widening the influence of natural selection. But, as Romanes, and especially Spencer, in his "Factors of Organic Evolution," have fully shown Darwin's position on this subject, I may pass over the detail.

INTERNAL CONDITIONS.—*Physiological.*—*Genesis* itself is the first and most fundamental of all causes of variation. The philosophy of sex may, indeed, be sought in this differentiation, as the accumulated qualities in separate entities when suddenly conjoined or commingled inevitably lead to aggregation and heterogeneity—in other words, to plasticity or capacity to vary. Genesis, as a fundamental factor in evolution, may be more intelligently considered under some of its subordinate phases, as heredity, physiological selection, sexual selection, primogenital selection, sexual differentiation, including philoprogeneity, hybridity, etc.

Heredity, as expounded by the ablest biologists, and as exemplified in life, is a puissant factor in evolution, and, though essentially conservative, must, through the marvelous power of atavism, tend to increase individual variability. The subject has been too well considered by Darwin and his followers to justify further discussion of it here. As a cause of variation, heredity must, however, have less and less influence as we go back in the scale of organized beings; for it can not well come into play in agamic or fissiparous reproduction, a fact which has given the abiogenisists one of their strongest arguments, since it is difficult to understand how, for instance, the monera of to-day could have descended without change from the primordial form.

Physiological Selection.—Physiological selection, as suggested by Mr. Catchpool and as expounded by Romanes, is undoubtedly a veritable factor in evolution, and, while giving us another link in the chain of evidence as to the causes of differentiation, lessens in but very slight degree the overwhelming force of the argument for natural selection. It adds, rather, an important element in the evidence therefor, and may be classed as a subordinate cause of differentiation. Romanes's theory is based upon the argument that differences, such as constitute varieties and species in their commencement, would not be preserved by natural selection unless useful, but would be lost again by cross-breeding with forms like the parent, and which had not varied, except upon some hypothesis like that of physiological selection. This could not be prevented except by migration. This difficulty is a general one, was argued by Darwin himself, and has been felt by all Darwinians. The reproductive organs are extremely variable, and sterility may occur not only between species, but between races and varieties, and often between individuals. Physiological selection tends to form varieties by peculiarities in the reproductive system of individuals, which render them unfit for perfect union, or cause them to remain more or less sterile, with other individuals which have not the same peculiarities.

The exact reasons are recondite, and the whole subject difficult of demonstration except from the results, since changes in the reproductive organs are not easily observable. Romanes believes this sterility to be incidental to variation, and hence one of the chief causes of the accumulation of such variation. Wherever there has been modification of the reproductive organs introducing incompatibility between two individuals, even where there has been no other change or variation, we have a valid cause of differentiation which in its consequences must be important. Compatibility or fertility between individuals is of the very essence of selection. Natural selection implies that this sexual divergence is subsequent to or coincident with divergences in other directions; physiological selection, that it antecedes them. To put the case of Romanes more fully, we will suppose that among the natural variations there occasionally occurs something to affect the reproductive organs in such wise as to produce incompatibility—i. e., incapacity of one individual with another of the parent type to unite, or sterility of such union, while it remains fertile with the variation of its own kind. This theory, of course, implies variation in the reproductive organs, or departure from the parental type, in at least two individuals of opposite sex simultaneously, and with this admission, for which we are justified in facts, physiological selection will preserve many peculiarities which need have no necessary connection with the exigencies of life.

The change may be in the organs of reproduction, introducing sexual incompatibility, or it may be due to other causes, as, for instance, the time of flowering in plants, or the season of heat in animals. Even the element of scent becomes important here, as my friend J. Jenner Weir has suggested, since it may influence sexual relationship, so that the very excretions of the body, which vary with individuals, must be allowed their part. Francis Galton has indicated a modification of Romanes's views, viz., that the primary characteristic of a variety resides in the fact that the individuals who compose it do not care to mate with those outside their pale. Incipient varieties are thus thrown off from the parent stock by means of peculiarities of sexual instinct which prompt what anthropologists call endogamy, and check exogamy or marriage without the tribe or caste. This is a very good anthropological illustration of how physiological selection may begin.

Natural selection preserves the individuals best adapted to life-conditions by destroying the less fit. Physiological selection may be said to preserve differences which have no necessary connection with the necessities of life. Neither touches the origin of the variation, but both express laws thereof or methods by which it is accumulated. The inherent tendency to vary, whether in external or adaptive structure, or internal or reproductive character, is simply an observed fact, the causes of which we are endeavoring to analyze.

Physiological selection is remarkably exemplified in insects, and probably in no other class are the modifications which may be attributed to it more easily studied; for in no other class are the genitalia of the male so variable or so complex. There has so far been no attempt to homologize the different parts in the different orders of insects, so that they have received different names according to individual authors. Ordinarily there are two pairs of claspers, themselves very variable, associated with sundry hooks and tufts of hair. There are families, as in the *Cecidomyidæ*, among the *Diptera*, in which many species are almost, and others absolutely, indistinguishable except by the differences in the male genitalia. In all other orders there are an immense number of forms which can only be distinguished by a careful study of those organs. Descriptive entomology to-day, which does not take account of these organs, is in fact almost valueless, and we must necessarily assume that, where there is differentiation of structure in these important parts, it implies a corresponding modification on the part of some associated female, even where no other differentiated characters are to be detected, and upon Romanes's law such must be looked upon as physiological varieties, and will be counted good species in proportion as the differentiation involves other observable characters or as their life-habits determine.

Sexual Selection.—The part of sexual selection in inducing variation may next be considered. While it is evidently at the bottom of the diversity in sex so common among many animals, it is difficult to see how it can play any very important part in the differentiation of species, except on the hypothesis that the greater the differentiation between the sexes the greater the tendency to vary in the offspring. In no class of organism is this factor more notable than in insects, and volumes might be written to record the interesting and curious facts in this class alone. As a general rule it may be said that with insects, as with other animals, it acts chiefly in inducing secondary sexual characteristics in the male, and in simplifying the characteristics of the female. Nowhere do we find greater contrasts between the sexes, involving almost every organ, both colorationally and structurally. Where color is affected, the greater brilliancy almost always belongs to the male sex, as in birds. So, where song or sound is employed to attract, the sound-organs are either peculiar to, or most highly developed in, the males. As in higher animals, also, so in insects, we find offensive organs highly developed in the male, and either lacking or but partially developed in the female, wherever the struggle for the possession of the female is by force or strength. It has evolved scent-organs in the various parts of the body, causing modification, especially in the *Lepidoptera*, of either the membrane of the wing or the scaly covering; it has induced profound modification in the structure of the legs, whether the anterior, middle, or posterior pair, and whether in the whole number or some part of it, or in its covering. The subject has been so fully treated by Darwin, however, that it is not necessary to elaborate it further in this connection. Strictly speaking, it may be said to act in two ways, viz., by conflict of the males for possession of the female, or by attractiveness, the former being most conspicuous among mammals, the latter among birds, and both coming conspicuously into play among insects. It is rather difficult to define the limit of sexual selection as a factor in evolution, but I would not confound it with another factor, not hitherto generally recognized, but which I think must be all-powerful, namely, sexual differentiation.

Sexual Differentiation.—It seems evident that the mere differentiation of sex in itself has been an important element in variation. The principle elaborated by Brooks as a modification of the theory of pangenesis is a good one, and in the main the male may be said to be the more complex and to represent the progressive, and the female the more simple and to represent the conservative element in nature. When the conditions of life are favorable, the female preponderates, and exercises a conservative influence. When the conditions are unfavorable, the males preponderate, and with their greater tendency to vary induce greater plasticity in the species, and hence greater power of adaptation. Sexual differentiation may, I think, be used to include many other variations and differentiations not otherwise satisfactorily accounted for, and to express the law of the interaction of the sexes upon one another, inducing great differentiation entirely apart from the struggle of the males for the possession of the females, or the struggle for existence. Among insects, particularly, though the same is true among other classes, we find many illustrations of this that can hardly be explained by the other forms of selection.

A few of the more notable in Hexapods may be instanced, as the degraded form of the female in *Stylopidæ*; in very many *Lepidoptera* and *Coleoptera*; in the females of the *Coccidæ*, in *Homoptera*, etc. In most of these cases it is the female which has been modified, without any very special modification in the male, though it is a general rule that, in proportion as the female is degradational and stationary, the organs which permit him to find her, or to mate with her, and particularly the antennæ, eyes, and genitalia, are profoundly modified and complex. This is especially noticeable in the *Psychidæ*, where the female remains in her case, a mere mouthless, eyeless, legless, and wingless grub, and the male has most complex and ramose antennæ and complex genitalia. Another remarkable instance may be cited in the *Lampyridæ*, where we find every degree of degradation in the female, from partial wings to no wings at all, accompanied with increasing complexity of eyes and antennæ in the male, until at last, in the *Phengodini*, the female is so larviform that she can hardly be distinguished from the true larva. In all these cases the female has been as profoundly modified as, and often more so than, the male, and in the latter case a phosphorescent power has been evolved so that the attractiveness, as in the human species, is rather on the female side. Again, in the case of *Corydalus*, in *Neuroptera*, the profound modification of the jaws in the male into prehensile, sickle-shaped organs is to be explained rather on the interaction, between the sexes, and the facility the modification offers for union, than upon sexual selection in its proper and restricted sense.

In this category must also be included the influence of *philoprogeneity*, which has modified the female rather than the male either in the primary sexual organs for offense or defense, as in the sting of the aculeate *Hymenoptera*; or in the secondary sexual characters, as in the anal tufts of hair, secretory glands, etc., of many *Lepidoptera*; or in modification of various other parts of the body exhibited in various orders of insects to facilitate provision for their young, whether in the preservation of the eggs or the accumulation of food for the future progeny. A notable instance of how far this may be carried is furnished by the female *Pronuba*, where the ovipositor and the maxillæ are so profoundly modified as to make her unique in her order. Sexual selection can have little to do with these modifications, cases of which might be multiplied indefinitely; nor can they be fully explained by natural selection, in the restricted sense in which we have proposed to use it; nor by physiological selection.

In this category might also be included modification which has resulted in the various forms of females which obtain in the same species, fitted whether for agamic or sexual reproduction, and which are far more readily explained on the theory of sexual differentiation aided by environmental influence, especially food and temperature, than upon any other.

Hybridity.—The subject of hybridity has been fully discussed by many, and by no one more ably than by Darwin himself. It has generally been assumed that the hybrid of any two species is sterile, and, in fact, hybridity has been looked upon as one of the best tests of specific value next to genetic incapacity. The assumption finds its greatest support in genesis among the higher animals, and the most thoroughly differentiated species; but the whole subject becomes complicated as we descend in the organic scale, and hybrids between what naturalists generally separate as good species are far more frequently fertile among plants and lower animals than was formerly supposed; while physiological selection, as we have just seen, may render genesis impossible, or at least prevent it, between varieties and incipient species. In this light, hybridity becomes an important factor in the modification of species. Unnecessary importance has been given, in my judgment, to the fact that domestic and wild species differ in the fertility of their crosses. It is assumed, for instance, that all the known breeds of domestic dogs would be fertile *inter se* and produce fertile crosses. It seems to me, on the very face, a preposterous proposition, and that many of the breeds of domestic dogs are as distinct specifically, and even generically, so far as this test is concerned, as they are in structure and other characteristics. Who, for instance, has ever known or heard of a cross between a bull-dog and a lap-dog, or between a Newfoundland and a black-and-tan? The difference in size alone would seem to render such a cross, if not a physiological or a physical, at least a practical, impossibility; so that hybridity among domestic animals tends to essentially the same result as among wild animals, and confirms its importance as a differentiating factor.

[*To be concluded.*]

THE STORY OF A SCHOOL.

By JAMES JOHONNOT.

IN this age of wholesale educational machinery the faithful record of any school, individual in its character, ought to be of interest to all who seek better results in practical ability than our present systems of instruction succeed in giving. But, when the school departs widely from recognized standards, its record is of double value, as calling in question prevalent customs, and affording a new criterion for the judgment of current methods. The tendency of instruction is to become set in its ways. Teachers follow precedent and reach formalism.

But from time to time particular individuals are found who ask the reason of this or that practice, and call in question its value as a means of culture. Hence arose the "teachers' institutes" in this country. They were first organized in the State of New York, in 1846. They grew naturally out of the progress in liberty of thought. Time-worn methods of teaching were brought up for discussion and judged by their results, and in the light of reason.

Credit is surely due the founders and conductors of institutes, in that they brought about and persisted in this habit of questioning and discussing educational practices and principles. This was their special field of work. Their method was the true one, but the laws of life and of mental development were not then well enough understood, even by the best thinkers, to furnish safe guidance in this difficult work.

"The new education" means a revolt against all precise, ready-made forms, and an adoption of such methods as science may from time to time discover and point out. The "Story of a School" tells of the trials and triumphs of an experiment designed to test educational principles at which I had arrived through many years of "institute" instruction. In this constant comparing, discriminating, and sifting of methods I had obtained a special preparation for normal-school work. Herbert Spencer, in his treatise on education, had laid a solid foundation for scientific education, and Prof. E. L. Youmans had with voice and pen succeeded in arousing among thinking people a lively interest in the subject.

In the year 1872, through the agency of the Hon. John Monteith, Superintendent of the Schools of Missouri, I received a call to take charge of the newly established normal school at Warrensburg in that State. In the interview with Mr. Monteith I said suggestively to him, "You do not want me, and your board of regents will not want my services when they learn the conditions I shall exact."—"What may these be?" said he, with some curiosity in his tone. "Entire control of the school, without interference from the superintendent or from the regents," was my reply. Laughing, said he, "You are the very man we want," and added, by way of caution: "You understand that liberty implies responsibility. Give us right results, and we will trust to you for methods." I accepted the situation, and took up my work under circumstances singularly propitious to the experiment I was about to make.

The first thing that engaged my attention was the preparation of a course of study. It was an easy matter to select the required document from the catalogue of some noted institution, or I might have made a mosaic, adopting parts from several. A brief inspection of various catalogues showed that little thought had been bestowed upon the order of subjects in the course. One study might be made to take the place of any other, without the slightest disturbance in their relations. Of the natural order of growth in mind, and of the corresponding sequences in the sciences, they had taken no account. To these laws I now turned for guidance, and tried to forget that a school curriculum had ever been constructed, so that custom should in no wise interfere with the free play of philosophic principles.

The subjects were arranged in their order of dependence as determined by comparative science. The course of study thus worked out differed quite materially from the ordinary, in spirit and in principles. It emerged as an organic whole, rather than as a loose array of disconnected subjects.

The physical sciences had first place, their treatment beginning with an observation of material objects and passing to a consideration of forces and of the laws of physical relations.

Another line of study treated of man and his environment. It began with a consideration of man as an inhabitant of the globe, dealing with geography, and it led up through history, literature, civil government, to mental and moral philosophy, and later on to rhetoric, logic, and political economy.

Besides these two main lines of thought, there were two subordinate ones, dealing respectively with language as a science and with mathematics. In our treatment of language the widest departure from the customary was made. Latin and Greek were excluded, as the State University already offered a much more complete course in the classics than our school could hope to give. But a still weightier reason constrained me in this decision. The time at our disposal for linguistic study was needed chiefly for constructive work in the vernacular. I determined to make the study of English thorough; I realized the power gained by an accurate and easy mastery of our own tongue, and I fully appreciated the æsthetic value of English literature in the cultivation of a refined and discriminating taste.

The constructive work was so managed that familiarity with composition preceded analysis, and the principles and rules of language were developed out of the pupil's own work. Grammar came out of language, not language out of grammar. The critical work of grammar and rhetoric was placed in the advanced course along with logic.

In this spirit, and by the general method here indicated, the whole course of study was arranged. The place occupied by each subject was not a matter of accident, but of philosophic dependence. The success of my scheme demanded intelligent and harmonious co-operation on the part of the faculty. I needed a select corps of teachers, and the freedom of choice secured to me by Mr. Monteith now proved of great importance.

For my first assistant I chose Prof. L. H. Cheney, who some years later was accidentally killed while making an excavation in connection with the work of a geological expedition under direction of Prof. Shaler, of Harvard. In years long gone by Prof. Cheney had been a pupil of mine; later we had worked together, so that I knew well his peculiar worth and fitness for the place.

Next came Prof. and Mrs. Straight, representatives of the most advanced thought of the time in educational philosophy. They brought original and fruitful contribution to the work now in progress, and henceforth were to me as my right and left hand. At the close of his stay in Missouri, Prof. Straight was called to the charge of a department in the Oswego Normal School. Later he went with Colonel Parker to the Côok County Normal School, Illinois. He gave all the energy of an intense nature to his profession, but died in middle life, his mind a storehouse of educational material, ripe for use. Mrs. Straight's refined intelligence and professional skill found equally ready appreciation, and she took a high position in each of these normal schools. Since her husband's death, she has been called to a responsible position in one of the state schools of Japan. The remaining members of the faculty were chosen for their fitness in special directions. The plans of each had their recognized place in a co-ordinate work. One of the chief defects in colleges and academies to-day is this lack of co-ordination. Without it the scientific method in its integrity is impossible, and instruction proceeds as though each science were independent. Time and strength are laboriously frittered away, with the result of chronic discouragement on the part of both professor and students.

"I declare," said one of our most observant pupils, as he came out from recitation one day, "the teaching in all the classes is somehow alike! It makes no difference whether we are in natural science, mathematics, or language, we are going the same road, and each lesson throws a new light upon all the others."

When the summer school at Penikese was organized, we made prompt application for a share in the rare opportunities offered. Only fifty students could be accommodated. Three of our teachers received the appointment, and accompanied me across Buzzard's Bay on that eventful summer morning in 1873. Agassiz "the master" was there, his face hopeful and inspiring. The last and noblest experiment of his life was about to be tried, and everything promised success. The promise was fulfilled. The many summer schools of science, springing up all over the land, are the direct offspring of Agassiz's realized dream; and the increasing recognition of the fundamental value of science by numerous prominent schools is also largely a result of his Penikese experiment. Our teachers again, the second summer, made haste to profit by the advantages of the Penikese school, and returned to their work in Missouri with added skill and devotion.

Our pupils represented every class of society. We opened with seventeen, and rapidly increased till the roll contained four hundred names. Within the limits of this paper only the bare outlines of our methods can be given. We began with the properties of things. The gardens and fields were open to us and furnished us the objects. When familiar with these and their relations, books were brought in to extend our knowledge beyond the limits of personal experience. The zoölogy and physiology classes, under Prof. Straight, were at once engaged in laboratory practice. They obtained their knowledge of the animal world from direct observation and through actual dissections. The neighborhood was laid under contribution for cats. Any feeling of repugnance at first shown for the work soon passed away as interest in the study grew eager and absorbing. The absurdity of rote-teaching was shown by an incident in the professor's class-room.

One day he called the attention of the class to the description of a certain sea-animal, as given in a popular text-book. This description he asked the pupils to commit to memory, which they proceeded to do, wondering why. One morning, only a few days later, the table was furnished with a specimen of this same animal preserved in alcohol. Not a member of the class recognized it. The elaborate verbal definition had given them no correct idea of the animal, if, indeed, any image whatever had been present in their minds.

In botany, books were unopened, except to aid in analysis. Materials for study the students found in their walks, and the keen delight awakened when examination revealed to them this new world of facts left no doubt that this was the very method of nature. The study went deeper than systematic botany, and led to an extended investigation of life processes in the plant.

Physics was taught in the laboratory and illustrated by apparatus which teachers and pupils united in making. This proved of double value; for, while primarily it helped to solve the problem in physics, incidentally it constrained the pupil to test knowledge previously gained by its practical application. The inventive powers were also stimulated, and a long step was taken in the development of faculty.

The teacher of geometry followed the method of Prof. Krüsi, of Oswego. This, in essentials, is the same as that outlined by Herbert Spencer in his work on education. It was developed incidentally out of the needs of constructive art, and was carried forward slowly, as the gradual progress of the pupil called for further applications of its principles. It was specially gratifying to witness the cheerful activity of pupils in this line of work, so often dreaded and shirked, and to watch the stimulating effect of power gained in mastering a difficult problem.

Drawing came in everywhere, being a mode of expression as natural as language, and indispensable to the acquirement of clear ideas; pupils soon made constant use of it, though, from lack of early training, their efforts had no pretensions to artistic merit.

Our lessons took various forms, depending upon the object we had in view. In the development exercises, by a series of questions quite in the Socratic spirit, we brought together the wandering, disconnected ideas which the class possessed upon any subject, and directed attention to the more obvious relations. The pupils were then left to work over the lesson, and arrange and present it in due order. This process became a guide, and pointed out the way for the next step in investigation. Lessons of instruction were usually given in the form of lectures. We, however, varied this exercise by substituting for the formal lecture a more or less familiar conversation, in which, after a little, all pupils took part.

Topical recitations included all knowledge obtained from books or reported from investigation. Day by day pupils were called upon to tell what they knew of given subjects in clear and connected discourse. The words of the text-book were not accepted; so every lesson became a language-lesson of the most practical kind. As a matter of fact, we found that, whenever a new thought was clearly understood, the mind sought expression in some form, either through constructive work, drawing, or language, and was not content until it had clearly imparted its meaning to another mind. The mental circuit was then complete.

In this reaching out after words and forms individual character asserted itself, the imagination was awakened, the invention quickened, and the dead monotony of the old-school recitation disappeared completely. This training finally resulted in an unusual mastery of spoken language.

Written work held a large place in our school. Our plan made provision for at least one written exercise a day for each pupil. As these exercises were in connection with the studies pursued at the time, the pupils entered upon them without any consciousness that they had begun the dreaded composition. Lessons from text-books, and aided by books of reference, were treated topically, and were frequently written out. Investigations in science were reported in writing, and in due time the pupils came to think easily and naturally, pen in hand.

In another regard we made a serious innovation upon custom. The teachers were not required to correct the wearisome mass of papers prepared daily. For this we had good reasons. The free use of criticism is a dangerous practice. It paralyzes the imagination of the pupil, and so depresses and discourages him that original constructive work is next to impossible. And if, as so often happens through the training given, the critical faculty of the pupil is developed in advance of the constructive ability, and of the power to use language with ease and accuracy, the result is fatal to progress in composition. The first rude efforts fall so far short of the polish demanded by the critical spirit that the sense of discouragement is overmastering.

There is still another view of the case that makes for the same distrust of promiscuous criticism. The errors of the early compositions are soon naturally and spontaneously outgrown through the constant effort at clearness of expression, and through the rapidly increased power over language gained by this continuous practice. In this way the mastery of language came incidentally, and we avoided the stiff awkwardness of the conventional composition.

In the study of English we did what we could to awaken the literary sense to some degree in all our pupils. We knew that each one came into the world with definite mental limitations. The literary sense, like any other form of the artistic faculty, seems, with rare exceptions, to require several generations of culture in a scholarly atmosphere before it attains to a fine discrimination. But we could at least make a real beginning. We could find out the present state of their taste, and carry forward their development by guiding their course of reading. Advantage was taken of events to bring before them some special poem, or some impassioned prose composition, having relation to the event in question. We could thus awaken a susceptibility of the soul, that through repeated impressions would develop into an instinctive sense of the beauty of true literary art-forms.

This was our aim, and quite subsidiary to this was the acquisition of knowledge *about* literature. The history, bibliography, and philosophy of English literature must come later instead of usurping the first place, as is commonly the case in schools.

In language, Prof. Campbell prepared an exercise which proved of great value. He selected about three hundred of the most productive roots of English words, and gave them one by one to the class. They traced these roots back to the various languages entering into the English tongue, and thus acquired a broader view of the origin and relations of English words. The study thus bestowed upon the vernacular was further valuable as furnishing a basis for the study of other languages.

When the student in Latin, French, or German finds that a large number of the new words he is learning have the roots with which he is familiar in his mother-tongue, the difficulties of his work are greatly diminished.

Mental and moral philosophy were taken up objectively and without the aid of books. Prof. Straight first developed the relations which knowledge sustains to mind, and the action of mind under varying conditions. He then took up some familiar subject and called upon the class to apply the knowledge thus far gained. For example, a flower was brought in and analyzed according to the laws of systematic botany. Then came introspection: what powers of mind had been used, and in what order? A lesson in geometry came next, and this was followed by the other school studies, until the list was exhausted. Next came the industries: what mental powers are brought into play in raising a crop, in building a house, in boiling a potato, in the making of bread? By this plan mental philosophy was lifted out of the fog of dreary abstractions and set on its feet in the broad light of every-day life.

Moral philosophy fell to my share. No books were used. My methods were quite similar to those of Prof. Straight. In a series of discussions, extending over several weeks, the human being was taken where Prof. Straight left him, and the relations developed that existed between him and other human beings. Needs were shown to exist by virtue of the "constitution of things," and deeper than this we did not attempt to go.

Human beings were seen to be *potentially* equal in needs, hence the necessity for equality before the law, that all might have opportunity for their natural development. Out of needs grew rights, and out of rights duties. A study of experience soon showed that duty assumed two phases—positive and negative. Confucius is credited with a maxim covering the ground of negative duty—forbidding injury to your neighbor; Jesus enunciated a law that summarized both positive and negative duty.

Next, the principles derived from this preliminary study were applied to the conditions which exist in school, home, and neighborhood. Why should a person work? What time should be given to recreation? What shall we do with the tramp? What with worthy but destitute men and women? What with needy orphans?

The discussion was conducted almost solely by the pupils. When it took too wide a range, the teacher quietly led it back to the question at issue. The lesson on one occasion dealt with card-playing. One young woman charged that it led to gambling and bad company. To this another replied that she had often played but never for money, nor had she the least inclination to gamble. As for bad company, she played with her sister, who was no worse company at the card-table than at the dinner-table. When I found that the discussion had become a mere assertion of opinion, I interposed: "You seem to disagree. Why?" "Yes," said one, who recalled my method of treating such cases, "we have not facts enough to enable us to form an intelligent opinion." "But," said another, "what is your opinion?" "My opinion is not the question. What are you to do next?" Wait, observe, and continue to study, was the conclusion.

Our history grew out of our geography, and, as we labored to build up in the mind of the pupil a connected and distinct picture of the skeleton—the mountain system of the globe—and then clothed these gaunt outlines with the trailing robes of continental divisions, showing also the necessary dependence of the water systems upon the great backbone of the continents, so in history we aimed at a unity of conception, we sought to develop an historic sense, which, once acquired, serves as a guide through the mass of unrelated facts filling so large a space in historical works, even of the higher order. This kind of training is too complex for description here.

And so of our methods of discipline: they were all intricate and intimate parts of our whole work. We had no rules, no class-markings, no roll of honor. We rejected the whole military system, as tending to produce mechanical, routine work. The abrupt tone of command was not heard within our walls. Directions were given in the form of requests. Teachers and pupils observed toward each other the usual courtesies of social life. No premium was offered for study. We relied on the natural incentives. Exercise of faculty is the chief source of pleasure in the young, and we furnished abundant scope for it. The time being filled with pleasurable occupations, calling into activity the whole nature, there was less temptation to misdemeanors than in the ordinary conditions of home-life.

Herbert Spencer's essay on moral education will best describe the work as it went on in our school, subject to the imperfections of human nature it is true, but with a result in general most gratifying.

The school as a whole soon attained a character of its own, derived from the aggregate of its members, and, reacting upon them, it became a potent force in stimulating the moral growth of individuals. This aggregate moral power was exerted for the most part unconsciously, but it was effective, and in time reached proportions which rendered my interference unnecessary.

An incident will here illustrate the operation of this power. A youth entered our school who had formerly been employed as train-boy upon the railroad. His experiences had greatly sharpened wits naturally keen, and as he came among us he was plainly seen to be an alien element. His evil propensities soon showed themselves. He told foul stories, but could get no listeners. He tried to pick quarrels with the younger members of the class, but a quiet word from one of the older pupils soon put an end to that; and, finally, he became angry and disgusted, and took himself away permanently. I watched this affair with much interest as a psychological experiment, but with some anxiety lest the moral leprosy should spread; but the character of the school told, and I was superfluous.

Another instance discloses something of the spirit prevailing among our students. The use of tobacco was discouraged incidentally in a variety of ways. We had a beautiful new building, and great care was taken to preserve it free from filth of any kind. A tobacco-stain, when observed, was removed at once with scrubbing-brush and sand. The physiology class, too, came upon the question of the action of tobacco upon the tissues of the body, and, besides, there was felt to be a social discredit in its use. One evening, while waiting for the mail at the post-office, a number of students on the same errand gathered about, and our talk turned on school matters. Allusion was made to our freedom from the restraint of rules. A late comer remarked: "But you have one rule, I understand. No one must use tobacco on the school premises." I assured him that, though I was opposed to the use of tobacco, I did not prohibit it. "But," I said, "no gentleman will soil the floor of a room occupied by ladies; and this fact, being understood, prevents its use more effectually than a positive prohibition." So powerful was the social reprobation of this filthy habit, that forty young men, of their own will, gave up the practice. It will thus be seen that our moral training, too, was largely incidental; it was implicit in every detail of school-life.

As will already have been anticipated, we dispensed with all distinctive religious services. I had carefully observed the effect in school and college throughout a long period of years, and had been forced to conclude that the evil results vastly outweighed the good. I had noticed that stated Bible-reading often became a mere lifeless form, in which many took no interest. This was contrary to the whole spirit of my system. "Vain repetitions," leading to a habit of regarding words apart from thought, were to be carefully avoided. Then, again, the teachings were dogmatic, appealing to authority, while science regards authority as an impertinence. Besides, the Constitution of the United States places its whole machinery upon a strictly secular basis, and religious services in a State school are there upon sufferance. No matter how carefully guarded, the daily performance of any religious service degenerates into formalism, and excites in the community sectarian animosities.

But, above all, I wished to place morals upon a scientific basis, so as to furnish a safe guide to conduct, independent of the shifting standards of theological belief. We, who received our appointments from the State, could not, honestly, either promote or attack any form of religious belief. Happily, the scientific method equally forbids doing either of these things, and, if strictly adhered to, will prevent all possibility of such quarrels between religious sects as have recently agitated Boston, and have from time to time interrupted the work of many schools in this country.

Our position on this question occasioned wide-spread comment, and, among the clergy of the more ignorant and bigoted sects, there arose an opposition, instinctive rather than outspoken.

The Missionary Society voted us a Bible, and I received a formal note from the secretary announcing the fact, and requesting me to appoint a time for the presentation to take place. I had been informed privately that, as soon as I fixed the time, a public meeting was to be called, and an address made denouncing our neglect of religious observances. In answer to the secretary, I informed him that our library was richly supplied with Bibles, but that, as a token of confidence and good-will, their gift would be highly prized, and we would gratefully receive the promised Bible at the president's office in the normal-school building, at such time as was most convenient to the secretary. The Bible never came.

Prof. Campbell, of our faculty, gave testimony of considerable significance concerning the moral atmosphere of our school. He had been educated in a sectarian college, and had been graduated at a theological seminary. All his prejudices were enlisted in favor of a daily religious service. He said: "I am at a loss to account for the uniform good feeling existing between teachers and pupils here. No student seems disposed to annoy or vex a teacher, and the moral tone of the school is much higher than I have before known." At first, he had thought that the good-will prevailing was in spite of the omission of religious services, but a more careful study had convinced him that the system, in its integrity, had created the moral atmosphere that pervaded the school.

Examinations, as usually conducted, had proved fruitful of serious evils. They gave opportunity for cram, and were often an occasion for cheating. When formal and stated examinations are held, on which class promotion depends, there is a strong inducement to make spasmodic efforts of memory serve in place of sound learning. We avoided these evils by a simple device. Examinations were held at irregular intervals, and were of such a nature that no miraculous feat of memorizing could meet our requirements. Repetitions of text-book formulas were habitually in disfavor, and necessarily there grew up habits of genuine study. These reviews were found sufficient aids in testing progress, and we dispensed with all other examinations.

After some effort toward conformity to prevailing custom, we found ourselves constrained by the guiding principles we had adopted to devise some more genuine representation of our year's work than is possible in "closing exercises" of the regulation pattern. Essays upon the subjects usually chosen had no essential relation to the student's past researches, and, being prepared for the occasion, represented nothing in particular. Besides, they are not uncommonly doctored by the teacher of rhetoric till they are of doubtful originality. We finally dispensed with all special preparation, and discarded all the spectacular features of the ordinary commencement.

One day was given to the public. Every four weeks during the year our pupils had been accustomed to select some subject having close relation to their studies, and to give time and care to the preparation of an essay upon it. These papers were preserved, and from among them each member was required to choose and bring one. On the last day of the term the public came in, and those interested stayed and listened to the reading of these essays. The truthfulness of every step was plain to all concerned, and was thus in accord with the spirit of the school.

Our experiment came to an end. Of the various innovations made upon custom each had justified itself. The effort to make character the end of education had more than fulfilled expectation. During the last year not a single case of misconduct was reported to me, nor was the behavior of one of our students criticised by the citizens. We had a reign of influence. The forces that govern conduct came from a growth within of just and kindly impulses. A watchful supervision had always been maintained, but into this had entered no element of espionage. The peculiar character which the school attained, both on its mental and moral side, was due to the several factors of influence—scientific methods in study, philosophic succession of subjects, and a never-ceasing but an apparently incidental attention to moral training.

Through the strong personal influence of the State Superintendent, Hon. John Monteith, my independent position had been maintained. I had enjoyed entire freedom in the management of the school and in the selection of teachers. During the three years of my stay in Missouri, educational affairs were in a transition state. At the close of the war, the public-school system was organized and protected by constitutional provisions. The best results of Puritan experience for two hundred and fifty years were incorporated in its provisions, and made secure so far as legislative enactments could compass it. More progress was made in the State during the few years of the so-called carpet-bag rule than in all its previous history. A State Board of Regents, non-partisan and largely professional, were in control throughout our first year. But the rebels were enfranchised, and reaction at once set in. The State Board was abolished, and a local board created, by its very constitution hostile to ideas.

Naturally, personal and sectarian interests would find expression. Members of the local board could see no reason for holding the office, when their functions were restricted to paying over money into the hands of Yankees, to be largely spent in the East during vacation.

Of the special influences that finally brought our experiments to a close it is unnecessary to speak in detail. Suffice it to say that our chief opponent stood before the people as a representative of wealth, and as the most prominent supporter of all religious enterprises. But below the sanctimonious exterior were the predatory instincts of the barbarian. His betrayal of trusts, his flight from outraged justice, his disappearance in the wilds of the Far West, his discovery at a lonely wayside inn, on a road leading to a mining-camp, prostrated by illness, without help, and hunted to the grave by detectives, afford a spectacle so gloomy that even retributive justice is shocked at the recital.

Recent experiments, introducing as we did the constructive arts as a means of expression, have again demonstrated their educational value; and I am persuaded that some time in the future the scientific method, with its freedom from arbitrary restraints, its ethical aims and accomplishment, will in its completeness take control of our leading educational institutions.

UNDERGROUND WATERS IN ROCK TRANSFORMATIONS.

By Prof. G. A. DAUBRÉE.

EVIDENTLY different actions from those which engendered the metalliferous deposits have propagated themselves through considerable masses, and have impressed a peculiar stamp upon them. The rocks that have been marked by such actions exhibit at once the characteristics of the sedimentary rocks and some of those of the eruptive rocks. While retaining the stratified disposition which they owe to their sedimentary origin, they are often studded with crystalline and anhydrous silicates, which they would not have contained if they had continued in their normal state. These rocks, of a somewhat mixed nature, are called metamorphic, a term given in allusion to the changes which they have undergone since they were deposited, and to which they owe their present appearance.

Stratified rocks have sometimes acquired these characters in the vicinity of eruptive rocks. In several localities of the Tyrol, the Triassic limestone in contact with melaphyre has been transformed into white marble for a thickness of more than five hundred metres, while pyroxene, spinel, tourmaline, and other crystalline minerals have been developed at the same time.

Clay schists have suffered mineralogical transformations in proximity with granitic eruptions. Even half a century ago, De Boblaye pointed out the presence, in Brittany, of fossil shells among the schistose rocks, which also contained, in testimony of the heat to which they had been subjected, large crystals of silicious minerals, as of andalusite or macle, and staurotide. The groupings of the latter species in the form of a cross have been long remarked, and have caused the name of *croisette* to be given to it. These remarkable modifications of the schists, which constitute a sort of radiation around the granitic flows, extend to distances varying from a few hundred metres to three kilometres. The heat to which the strata have been subjected by the intrusion of the eruptive mass is undoubtedly one of the causes of it; but the watery emanations which accompanied the eruption of the granite, and which are revealed to us by inclusions in the mass, attest that water has played a no less important part in it.

There is, however, something still more remarkable than this in the phenomena of metamorphism. Sedimentary rocks, occupying whole regions, bear evidence of profound modifications, without its being possible to discover the slightest eruptive cropping out. One of the most common examples of this phenomenon is that in which clay rocks have become phyllads. The rocks of that name, although they consist essentially, like the clays, of silicates of alumina, differ from them in their cohesion. They refuse to mix with water. The strata of the Ardennes, the Taunus, and other regions of western Europe, in which this mineralogical condition was first verified, belong to the most ancient geological epochs; and from that fact this crystalline texture was for a long time regarded as exclusively appertaining to sedimentary deposits of a very remote age. Hence the name of transition beds which was given them. It was thought that in the sea in which these matters were deposited, following the primitive or crystalline beds, there continued to operate a chemical precipitation of silicates which were mingled with arenaceous and calcareous deposits. It was subsequently recognized that this half-crystalline condition resulted from a transformation posterior to sedimentation.

The opinion that the mineralogical condition of these beds is not a necessary consequence of their antiquity, receives confirmation from the fact that formations in other countries, also belonging to the most ancient systems, do not participate in these crystalline characters, but in their argillaceous rocks are similar to those which are found in recent formations. This is the case in Sweden, Russia, the United States, and Canada. But it has been observed in those places that the strata have not been strongly dislocated as in the regions we have just been speaking of, but have retained their original horizontality. To this circumstance they doubtless owe their preservation. The mineralogical contrast between formations of the same age corresponds, therefore, with an essential difference in their bearing.

There are countries where formations of less antiquity have also suffered profound transformations. The Alps afford fundamental data on this subject. In the face of the rocks of different ages—Carboniferous, Triassic, and Tertiary—which enter into their composition, one is surprised at the special physiognomy which each one of them presents as compared with what we observe in beds of the same age in other regions, where they have remained horizontal. A general influence has, therefore, acted upon a part of the vast region of the Alps. It has affected rocks of every epoch, even those of the Lower Tertiary—that is, a series of beds many thousand metres thick—and that, although eruptive rocks are very rare in it.

With the mineralogical changes which we have just noticed is associated a modification of texture that depends on the same cause. It is well known in the slates as the schistose or laminated structure. The fissile rocks which it characterizes have the property of detaching themselves in thin plates—that is, of cleaving in certain directions. Observations made in various countries have demonstrated the important fact that the planes of cleavage are quite distinct from the planes of stratification. Instead of being parallel to the layers, they are frequently oblique, and—what is still more conclusive—while the planes of stratification have been bent and exhibit a variety of inclinations, the planes of cleavage pursue a regular direction, regardless of the most pronounced inflections, and remain constantly parallel to one another. This independence shows, besides, that the planes of cleavage were produced, not only after the beds in which they are manifest were deposited, but also after they had lost their primary horizontality. The schistose disposition, very frequent in the most ancient fossiliferous rocks, sometimes persists in more recent formations, when they have been subjected to energetic dislocations. In many localities of the Alps slates are quarried into the Tertiary formation.

An important characteristic of the schistose rocks is the considerable deformations which the fossils in them have received, as is seen in the trilobites of the Angers slates. Not less frequently, the molluscan fossils called belemnites have been broken up and had their segments more or less scattered.

Since the schistose structure has been found to be independent of the stratification, the cause of a geometrical disposition so remarkable and so general has become the subject of various hypotheses. It has been successively attributed to electric effects, to terrestrial magnetism, to the heat of the globe, and to a beginning of crystallization. Exact observations, however, teach us that the cleavage of stratified beds is related on the one hand to the actions which have deformed the fossils in the same strata, and on the other hand to the axes of the warping and the great lines of dislocation. The phenomenon should most probably be attributed to mechanical action.

The demonstration has been confirmed by some very simple experiments. Clay under compression assumes a leafy texture; but, for this, it must have a certain degree of plasticity. If too dry, it crumbles; if too wet, the laminæ, while they are formed, are not separable. I have got more decisive results from forcing clay to flow, in a jet, under hydraulic pressure. In this case, very well defined leaflets are produced, and that upon bands of several metres, in the direction of the pressure and the movement. All of these artificially laminated pastes resemble natural schistose rocks in their fracture. In these various flows of the plastic mass, the neighboring particles do not advance uniformly. The differences in the velocities which they acquire cause them to slide upon one another; and the schistose texture, the direct consequence of this sliding, is, we may readily conceive, necessarily determined in reference to the direction of the flow. The deformations of fossils and the drawing out of belemnites have been reproduced in this way, and thus experimentally explained.

We shall now consider how the fundamental facts of metamorphism imply the necessary action of subterranean waters. The mineralogical modifications peculiar to the phenomena have incontestably taken place at a higher temperature than now prevails on the surface of the globe. We base this conclusion upon the analogies of these beds with the eruptive rocks, and especially upon the presence of numerous anhydrous silicates, which form one of their most remarkable features. The proper heat of the globe decreasing from the deeper parts toward the surface, the sediments deposited in the ocean, at the relatively low temperature that reigns there, should, when they have been covered by other strata, acquire a higher temperature by reason of their greater distance from the radiating surface. The superposition of masses as heavy as are those of some of the stratified beds has often been enough to determine, after their deposition, a considerable heating up of the lower masses, especially at periods when the increase of heat downward may have been at a more rapid rate than now. Thus the regular propagation of the heat of the globe has been competent to act upon entire formations.

There is, however, another source of heat, at once more immediate and more energetic, for the transformations with which we are occupied, although it has been long misunderstood. Heat is engendered by the mechanical actions that have left their marks at numerous spots on the crust of the globe. Instead of preserving the horizontal position which they assumed when they were deposited, these beds have often been thrown up, folded, and contorted in various ways; and the resultant dislocations are observable through several thousand metres of thickness. At every step, in the Alps, for example, in the face of escarpments where the rock shows itself to the quick, the least observing eye is attracted by the boldness of the inflections, and the mind pauses stupefied before the grandeur of the forces that have produced such effects. Not all the labor put in play in these colossal upthrows has been employed in actions purely mechanical. A part of it has been transformed into heat, and it is the effects of this heat that we have been studying.

Experience has come to confirm the last induction also. Clay has been forced to flow either between cylinders like those of iron-rolling mills, or under trituration in malaxating tubs, such as are used in some brick-yards. In either case the rock is considerably heated up after a very short time, without subjecting it to any material pressure. In these operations the heating is greater in proportion as the clayey part is harder and more resistant. We have then reason to believe that in nature, when rocks more coherent and less plastic than ordinary clay have been submitted to mechanical actions powerful enough to determine an interior movement, even if it be of little amplitude, they will be found in conditions still more favorable to their being heated. It has, therefore, been enough for argillaceous masses to undergo a lamination under the effect of dislocations in the crust of the earth for their temperature to be notably raised.

But heat alone, however intense it may be, can not explain the most characteristic effects of metamorphism, nor the uniformity with which they have been produced over considerable spaces; for the conductivity of the rocks is extremely weak. Then, contrary to what would be the case were the action simply a calorific one, the effects have not always been most energetic in the parts in contact with the eruptive rocks. The water included in all the rocks, whether in their pores or in combination, has of necessity intervened as an auxiliary to the heat. The nature of the minerals produced, of the hydrated silicates, like chlorite, for example, no less than the uniformity of their disposition in vast masses, denote the intervention of this interior water. Thus, in this order of geological phenomena, when we might have believed that heat, accompanied by certain chemical actions, was the sole agent, subterranean water has also had its part to play.

This conclusion regarding the fundamental cause of metamorphism, although it had been justified by observation, still needed an experimental sanction. For that, the investigator should put himself in circumstances as nearly as possible like those in which Nature seems to have acted, and obtain the reproduction of characteristic minerals. I have tried to realize this. The principal difficulty in operating under the enormous pressure acquired by the vapor of water when the temperature approaches the point of dull redness is to find walls capable of resisting it. Water having been placed in a glass tube, which was then sealed by a lamp, this tube was introduced into a second tube of iron, with very thick walls, which was also closed, but not without difficulty, at the forge. In order to counterbalance the tension of the vapor in the interior of the glass tube, which might cause it to burst, care was taken to pour water outside of this tube, between its walls and those of the iron tube. The apparatus was set upon the dome of the furnace of a gas-factory in contact with masonry at a dull-red heat, in a thick bed of sand, where it remained for several weeks. Under these conditions, explosions of extreme violence took place. The most strongly resistant tubes were thrown into the air, bursting with a noise comparable to that of a cannon-shot. It was not possible to multiply the proofs to the extent that was desirable; but those that were made were sufficient to reveal facts quite different from those which we had deduced in laboratories under ordinary conditions.

The water acted very energetically upon the glass, which underwent a complete transformation, in composition and appearance. It was replaced by a white mass, quite opaque, resembling porcelain, with swellings and blisters, the results of softening. There had been developed, at the expense of a part of the substance, numbers of minute crystals, colorless and limpid like rock-crystal, with which they are identical, even to small details in the forms. These artificial crystals appeared, now isolated, now grouped into geodes which it was impossible to distinguish, except for the difference in dimensions, from those of nature. Another product of the same experiments deserves no less attention. It is pyroxene, which appears in little green, brilliant, and transparent crystals, exactly like those of the Alps. For the first time an anhydrous silicate had been seen to be produced by the action of water.*

* More recently, feldspar has been imitated, under similar processes, by MM. Friedel and Sarrasin.

The acquisition of another kind of power by water under such conditions was exemplified by the conversion of pine-wood into a bright and hard black substance resembling anthracite, and consisting simply of carbon associated with small quantities of volatile substances. It was shown, by its granulation in small globules, to have passed, in the water, through a kind of fusion, The reactions from which these products resulted are all the more interesting because they were obtained with a very small quantity of water, hardly equal to a third of the weight of the metamorphosed glass. Furthermore, the new products crystallized at a temperature considerably lower than their point of fusion. It is thus proved that water highly superheated acquires an energy that was unknown to belong to it. It destroys combinations that were reputed to be stable, and in the presence of which it was regarded as inert; and it composes others, among which are the anhydrous silicates. The production of these silicates in the crust of the earth escapes our observation, because it requires a temperature greatly superior to that of boiling water. But it must be going on in the depths of the rocks, where there is no lack of imprisoned water, nor of temperatures and pressures incomparably higher than those of our most potent experiments. It is hardly necessary to say more concerning the application of these synthetic results to questions concerning the metamorphic transformation of entire regions.

Other facts in nature are explained in these experiments. First, they teach us the origin of quartz in the crust of the earth, where it appears everywhere and in the most diverse bearings. Have not the veinlets of this mineral, for example, which traverse quartzites and phyllads in every direction, probably separated themselves at the expense of the incasing rock, and in the presence of water and heat, just as the quartz was extracted from glass? An action of the same kind is recognizable in the metalliferous veins. Sometimes the temperature there is high enough for the silicates also to be generated. The veins in which the green emeralds of Peru are found associated with crystallized quartz, calcite, and pyrites are evidently of aqueous formation.

Thus, by going back to ancient periods, we have seen how numerous species of minerals are produced concerning whose origin the observation of facts occurring to-day can not inform us. These numerous minerals, whether metalliferous or stony, occurring in various formations, are the final result of the work of water, which is found in some way stereotyped in them. We have thus succeeded in discovering the intimate operations of that liquid in laboratories which it abandoned long ago, in fissures of greater or less magnitude, and in blisters or the simple pores of the rocks. We are instructed concerning the manner in which it circulated, by vestiges of different kinds which permit us to reconstitute the various circumstances of its course.

The external features of an organized being make its constitution known only in an incomplete manner. An adequate anatomical study must penetrate to its interior organs and tissues. Thus, existing thermal springs, even if we take care to scrutinize in the most careful manner the constitution of the country and the conditions where they issue, do not suffice to reveal their economy with precision. Their constantly flowing columns of water, even when they are not accompanied with irrespirable gases, prevent our reaching their channels of ascent. In the very exceptional cases in which it is possible to penetrate below their orifices of emergence, as at Bourbonne and Plombières, the curious facts which we observe cause us to regret that we can not descend lower. Nature seems to have desired to withdraw from our sight the actual workings of subterranean waters, especially when they are engendering minerals. Water is not more rare than heat in the masses of the interior of the globe. Even when it does not circulate in natural channels, it is at least present, held imbibed in the most compact rocks. In clays, although combined, it is not less susceptible of acting chemically than in the free condition. Thus, what we have obtained only with many difficulties in our experiments, the action of superheated water, is found vigorously exemplified everywhere in the interior of the rocks, where the effective resistance to enormous pressures permits the realization of more complete results than are possible with the fragile apparatus of our laboratories.

The circumstance that heat stored in masses of so little conducting power as stony substances is preserved for a very long time, is eminently favorable to chemical combinations and to crystallization. Nature possesses another superior advantage over man in having extremely long lapses of time at her disposal. The importance of this advantage, in the application in which we are now regarding it, appears plainly from what has occurred in the Roman masonry of Plombières. Besides this, reactions which go on slowly do not require so high a temperature as those that are of shorter duration.

The study of waters in their course and effects in ancient epochs thus seems to complete the history and broaden the view of their subterranean works. Here, then, a real exchange of light takes place. The past illuminates the present as much as the present illuminates the past. There is nothing, moreover, to prove that phenomena of this character do not continue down to our own days. We have a right to believe that similar actions are still going on, but in interior regions beyond the reach of our powers of observation. Superheated water, which betrays its existence through thermal springs and volcanic exhalations, to all appearance is slowly and silently engendering considerable and permanent effects in the interior of the globe, and is giving birth to various minerals as it did in former days.

In the same way as in our organism all the parts of the body owe their development to the support which they receive from the circulation of the blood, so in the crust of the earth, water, by its incessant subterranean circulation and its predominantly chemical work, accomplishes a kind of vital action which is perpetuated through ages. May we not justly apply to these mineralogical and geological results, so worthy of our curiosity and derived from a single cause, Leibnitz's favorite epigraph, *In varietate unitas ?—Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE ORIGIN OF HOLIDAYS.

By HARLOW GALE.

AS ballads are the essence of a people's history, so holidays are the free utterance of their character. Spontaneity is always valuable evidence, and holidays are in their beginnings purely spontaneous. They furnish psychically an excellent example of reflex action. The stimuli which come to us from the outer world of things as well as from the inner world of sensation find three channels for the expenditure of their force, viz., thought, feeling, and involuntary or reflex action. Man's position in the scale of life is determined in general by the proportion in which stimulus is distributed among these three outflows. The less of conscious life a creature has, the nearer will it approach to the existence of an automaton.

Now, though we can not precisely construct the psychical life of the primitive man, yet the law of evolution enables us to picture him as exercising little reflective thought, rather dull feelings of the bodily pain and pleasure sort, and a comparatively large amount of reflex action; so that stimulus, following the line of least resistance or greatest traction, will in a majority of cases end in reflex action. Even if the incoming sentient current does flow on or over into feeling and even thought, the smallness of their capacity prevents much egress through these intellectual channels, and the restricted current must again find its exit in expressive muscular action. Let us briefly review the historical beginnings and development of this spontaneous demonstrative life.

The primitive holiday was occasional—i. e., prompted by unusual events of domestic or tribal life. Births, marriages, and deaths are almost universally celebrated by primitive man, and we must remember that his feelings connected with death are by no means such as ours. Though the pains of separation and loneliness have come to be widely differentiated from those joyful, generous feelings connected with the beginnings of domestic life, yet with the savage it was more fear than affection which prompted the propitiation of the ghost of the dead, and a gift of presents for its use in the future world. The Pacific islanders, Asiatic peoples, African tribes, and American Indians, all, in one way or another, feast and sacrifice on occasion of the principal family events. Among the Karens a corpse lies in state three or four days, amid marching around to music of pipes, singing, lamentation, and athletic games. The Javanese have religious festivals for marriages, births, circumcision, and for the dead. The Tongans celebrate their chief's marriage by dancing, single combats, boxing, and wrestling. On the birth of a child the feasting, sham fighting, night-dancing, etc., last for several days among the Samoans.* The principal friends of newly made parents among this same people bring presents on the third day after the birth of the child, according to an invariable rule, by which the husband's relatives bring pigs, canoes, and foreign property, and the wife's relatives bring fine mats and native clothes made by the females. These interchange their gifts and leave the parents as poor as before. The Malagasy's ceremonies, bull-baiting, dancing, singing, beating of drums, etc., at circumcision, last a week or even months. The Hottentots have feasts of eating, drinking, and smoking on the admittance of youth to manhood and womanhood, and on occasion of marriages and funerals. On the death of a king of the Congos † no work must be done, the natives stay at home, while the fields remain uncultivated for a month. A king's death among the coast negroes, Ashantees, and Abyssinians, however, is the signal for general lawlessness and plunder. The destruction of property, feasting, and sacrifices at an ordinary funeral often ruin one of these families. The celebrations of the Santals are few and simple: at admission into the family, tribe, and race; at marriage, divorce, cremation, and the reunion of the dead with their departed fathers. The funeral games of the Kirghiz are racing, wrestling, and trying to catch a coin out of a vessel of sour milk.

Coming to higher types of men, with more social and political coherence, the number and variety of festivals increase. They cease to be held for domestic events alone, but are extended to such tribal matters as, among the Abipones, councils of war, im-

* Spencer's "Descriptive Sociology," No. III, Table XII, p. 27, "Lowest Races, Negrito Races, and Malayo-Polynesian Races."

† Spencer's "Descriptive Sociology," No. IV, "African Races," Table XXIV, and page 18.

pending fights, victories, birth of a chief's son, change of name (done at funerals), arrival of distinguished visitors, or the proclamation of a new chief. Among the Malagasy a grand feast, accompanied with dancing, music, and sports, terminates the ceremony of a treaty. The Mandans * hold a feast of the bull-fight, on which depends the coming of their supply of buffaloes. Two feasts are given by the Hottentots at the installation of a chief of a kraal: one by the person installed, when the men eat all the meat and give the broth to the women; and the second, given by the wife, when the women get the meat and the men the broth. The New-Zealanders give great feasts and Olympian games to other nations. In their national pride to outdo each other in prodigality the collection for these feasts is begun a year before, and the extravagance often produces a famine, so that the natives are obliged to leave their settlements till their crops are ripe. Cannibalism is simply the Fiji style of an occasional feast. Before going into war the Tahitians offer human sacrifices; and at the coronation of their king there is a great religious festival in honor of the monarch, whose girdle of red feathers identifies him with the gods. Different districts among them challenge each other to public games, e. g., wrestling, boxing, foot-racing, canoe-races, spear and javelin throwing, military and naval reviews, ball, archery, cock-fighting, surf-swimming, kite-flying, etc., all of which are also often connected with religious ceremonies or a cause of national rejoicing, such as the return of a king or the arrival of some distinguished visitor.

The transition from occasional to periodic festivals is through the various harvest celebrations. The Congos have a great harvest feast at the ripening of the yams, and the Ashantees celebrate the same event with processions and sacrifices of slaves. Sacrifices are made to the late village head of the Santals, at each stage of rice-planting. Three great festivals are held by the Gonds—at seed-time, at harvest, and when the mhowa flowers. A feast is also kept at the end of a monsoon to the god of rain. The Creeks have a religious feast of four to eight days on the ripening of the crops. A feast of first-fruits is held in January by the Kaffirs. At the sowing of the rice the Dyaks have three festivals: in the midst of the cutting down of the jungle, when it is set on fire, and the blessing of the seed before planting. At harvest are three more: feast of the first-fruits, of the middle of the harvest, and to secure the price of rice.

The next stage in the development of our ancestral holidays is one of great importance. In this one primitive astronomy begins, our calendar has its genesis, and domestic, civil, and political life begins to assume something of that order and regularity which

* Spencer's "Descriptive Sociology," No. VI, "American Races," page 17.

inspires confidence between man and man, and gives stability to customs and institutions.

We can hardly appreciate the meaning of the appearance of the new moon to the primitive man. It was the herald of a new season of light to dispel his natural dislike and even fear of darkness. The old Hindus and the Arabs through the Syrians sacrificed at new and full moons. The Tasmanians danced at full moon. One of the earliest recorded festivals of the ancient Hebrews is that of the new moon. This event was regularly celebrated by the chief of the Nootka Columbians, by causing a slave to be killed to furnish a banquet, amid songs and dancing, to the other chiefs of lower rank. A certain phase of the moon was also the most frequent natural periodic event to suggest the memory of events celebrated at the last moon, and were this memory vivid enough the savage would be moved to renew his demonstrations. The Uaupés laments his dead from the time of death to burial, and follows this with an Irish wake. Then a lunar month after death the corpse is disinterred, roasted in a pan, the remaining black mass is powdered, mixed with drink, and drunk. The funeral wake among the Abyssinians is held some months after the funeral.

When man's memory grew stronger with his development, the natural solar divisions of time acted as stimuli on his mind to commemorate festival events. The ancient Peruvians feasted each month of the year, but had their principal feasts at the solstices and equinoxes. To the Sol grove, the abode of the family gods or deceased ancestors, the Santals repair yearly, to worship with dancing, music, chanting songs in memory of the founder, and to hold sacrificial feasts of goats and fowls. Each family danced about the tree, supposed to be the abode of its own god. The Karens* have an annual feast of the dead at a new moon, when the deceased are supposed to be present, and partake of the food and receive addresses. Among the Kalmucks four yearly feasts are held: (1) New-year's, lasting for several days, with feasting and good wishes. (2) Summer festival, with wrestling, horse-racing, etc. (3) "Consecration of the water," when bodily and spiritual ailments of the bathers in the water were cured. (4) "Candle festival," at beginning of winter, when lights are lit in the temple. The most important and popular feast among the Malagasy is the New-year, or "bathing," that being the principal part of the ceremony. Ten or fifteen thousand bullocks, however, are usually killed at this time, and sacrifices are made to the gods and at the tombs of the king's ancestors. The funeral ceremonies of the Todas are usually celebrated annually by feasting,

* Spencer's "Descriptive Sociology," No. V, "Asiatic Races," Table XXXVII, and page 23.

dancing, and slaughtering of animals. Among the Arabs there is an invocation of the dead, and sacrifices at the tombs of the chiefs once a year. The Eskimos hold religious feasts about the winter solstice and at New-year's. A yearly celebration of a tradition of a deluge is observed by the Mandan Indians. Among the ancient Phœnicians mourning rites were repeated annually.

We come now to consider how the more or less artificial subdivisions of time came to be used for periodical celebrations, and ultimately became fixed holidays. There appear historically arbitrary days, such as the three post-natal feast-days given by the Gond mother. On the fifth day after the birth of her child her female friends are feasted, male friends on the twelfth, and both together again on the thirteenth. Such an arrangement of dates is probably determined by the physical state of the mother and some conditioning social customs. It is by division of the lunar month, however, that the development continues among the more civilized peoples. A triple division in Tibet gave their original fast-days the 9th, 19th, and 29th; the Mongols, having fixed temples far removed, held three successive days, the 14th, 15th, and 16th; those of the Kalmucks are the 8th, 15th, and 30th. But, when the old Hindus, Arabs, and Syrians sacrificed at new and full moons, the beginning was made toward the Jewish Sabbath and our Sunday. The fourfold division of the lunar month by full and quarter moon religious or sacrificial feast-days gave the week and the magic number seven. With the Babylonians, the 7th, 12th, 21st, and 28th days of the month were called days of "sulum," or rest; certain works being forbidden on these days. This expression was transmitted from the older Accadians. Each of these days was consecrated to a different god, one of whom was the moon. Whether the Congo negroes got their frequent Sunday by a sevenfold division of the month we can not say positively, but it is certainly very significant that every fourth day is with them a general day of rest from work in the fields.

This process of subdivision is especially interesting to trace in Semitic and Jewish history, for it shows the perfectly natural rather than the supernatural origin of our "day of rest." The month is the old sacred division of time common to all the Semites. The Mohammedan and Jewish calendars are still lunar. The Semitic word "ahalla," meaning "to greet the new moon," was used of any festal joy, and became the type of religious festivity in general. "In the old Semitic scriptures the new moon and the Sabbath are almost invariably mentioned together." There were the same occasional feasts which we have found in the life of other barbarous peoples, much the same equinoctial, solstitial, and yearly festivals, so that the permanent subdivisions of the lunar cycle by a ceremonial and emotional race was a most natural progress of their enlarging life. At the middle of the tenth century B. C., there were, besides the annual feasts of unleavened bread, harvest, and ingatherings, those of the new moon and the Sabbath; and these latter still retained their primitive characteristics of joyful days of rest and assembly. In fact, owing to the popular reluctance to class religious days, and particularly the ancient Sabbath, as holidays, "we can not refrain," with Deutsch, "from entering a protest against the vulgar notion of the Jewish Sabbath as being a thing of grim austerity. It was precisely the contrary—a day of joy and delight, a feast-day, honored by fine garments, by the best of cheer, by wine, lights, spice, and other joys of pre-eminently bodily import." So here the same objection should be met which was anticipated in the case of funeral ceremonies and festivals. All primitive religious ceremonies and days, whether they be in connection with ghost, fetich, or Nature worship, are of this spontaneous emotional character which is the essence of holidays. It is doubtless true that, when in the course of the development of a religion the spontaneity lessens, and with more expressionless feeling and calm thought the religious life of a people crystallizes into mechanical forms and creeds, then austerity and asceticism have dried up the holiday heart in church-days; but when the reaction comes, and the Church in fear and horror calls us to defend her acquired prerogative, we are assured, by such an inquiry into the origin of her days, that either the creeds and commandments must be periodically modified to the needs of human nature, or that mankind will find more radical vents for its spontaneity. The founder of Christianity saw the necessity in his day for the rebuke that "the Sabbath was made for man and not man for the Sabbath." We to-day see that man has made his own Sabbath; being his own, he must not and can not be kept from his heritage.

This suggests the question, How has the direction of holidays come to be taken from the hands of the participants? The answer is obviously found in the course of differentiation and specialization which holidays have undergone. The domestic festivals, which included only relatives and friends, were at first purely spontaneous with each individual or circle. As the ceremonies became more elaborate and prolonged, the father, eldest son, medicine-man, or chief became director, until with further elaboration into fixed and regular forms of emotional expression, there arose the beginnings of a specialized class of priesthood. When they had obtained full control, there arose the phenomenon, remarkable in that it continues to our own day, of the priesthood's trying to formulate the reasons for the ceremonies and existence of church-days, and these efforts taking on the shape of creeds and commandments—which, however necessary as expedients, touch the truth only most symbolically.

The hint has already been several times offered that holidays, starting in the psychological way of reflex action, have had their growth according to the law of all growth—evolution, by which they have progressed from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity. A caution must be interposed here, however, before the completion of the law is pointed out. It must not be supposed for an instant that the development took place in such distinct steps as might be inferred from the grouping of our historical references: that domestic festivals were completely or at all generally in custom before tribal or national demonstrations came into vogue; that only after these were current in an occasional way were harvest festivals held; and that not until the moon's cycle had been quartered did the recurring solar periods become associated with regular emotions. On the contrary, each of these logical periods largely overlapped the next, so that nearly or quite all of them have been contemporaneous in various degrees of advancement. We can only hold that, on the whole, the growth of holidays has been according to some coherent method whose outline is found to be the law of evolution.

The completion of the law is that with the increase and specialization of holidays there has been a concomitant loss of emotion, but that the retained emotion has undergone a like process from homogeneity to heterogeneity. This is seen in the fact that though the Africans and Polynesians show that holidays began as overflows of emotion, yet on ascending through the history of the Indians, Asiatics, Americans, and Europeans, festivals have become less demonstrative and more varied and restricted in their meaning. This fact gives us the key to the radical change which has taken place in the character of our modern holidays as compared with those of primitive man. As man became capable of quiet feeling and reflective thought, the various internal and external stimuli were less and less forced into reflex demonstrative action. He could experience joy and sorrow, bravery and hospitality, reverence and worship, with an ever-lessening muscular action. Most of all, perhaps, is the change due to the share of stimulus which went to thought. This is first seen in the difference between occasional and periodic holidays. The periodic days added to the pure spontaneity of occasional days the new intellectual element of association of ideas. Certain feelings came to be associated with certain phases of the moon or seasons of the year, the periodic recurrence of which revived with lessening intensity the emotions and reflex actions of the original event. The calendar festivals came to *mean* more; though they lost in demonstration, they gained in thought: free gladsomeness grew serious. Thus it came to pass that religion and the Church appropriated so many of Nature's festivals; that the Roman *Saturnalia* became our precious Christmas, the full-moon spring equinoctial feast grew into our beautiful Easter, and the harvest feast took the form of a Thanksgiving service.

These changes suggest the function and future of holidays in the light of their origin. As shown above, the psychical growth of man from an emotional to an intellectual creature has almost entirely changed the function of holidays. The truest survivals of the primitive emotional reflex-action function is seen in the children's April-fool's-day and our modern wedding shows. But the element of association, which was the genesis of our periodic days, is of more lasting power. The intense rush and struggle for existence of the modern world found less time for occasional festivals, and so needed more of the periodical reminders of events which our fathers or our ancestors first celebrated. But we note now an appearance of decadence which seems inevitably to await holidays. The original cause for the day being forgotten, from being a day of amusement, joy, and gayety, set apart in honor of some person or in commemoration of some event, it became a consecrated day, a religious anniversary or national festival, until it acquired the modern distinctive characteristic of a day of exemption from labor. To be sure, a feast always necessitated a change from ordinary occupations, but this was only an incidental condition to the expression of emotion. This function of a "rest-day" came into prominence, as we have noticed, with the Accadians and Babylonians, but it naturally has only become predominant in a pre-eminently industrial age. For the sake, then, of inculcating Mr. Spencer's text, "Work to live, and not live to work," if for nothing else, holidays still have a claim to our support; and we as a people are not so far removed from barbarism but that such wholesome texts and demands, even of nature, come to us more imperatively and efficiently in the guise of custom or in the name of religion. So, though our national holidays are fast losing their original meaning, and though church-days, and particularly Sunday, tend to become secularized, let us hold to them, under whatever form or sanction, for the sake of their modern function.

Are we, then, ultimately to lose holidays? Not to be too confidently prophetic, but judging by the historical tendency, we would answer, "Yes" and "No"—yes, as to the distinctive calendar demonstrative days. With the decadence of the emotional function, however, we found that the function of suggestion of deep feeling and many-sided thought remained and increased. Because our sensations *mean* more to us, because the thousand and one phenomena of our daily life are arranged and related in most delicate articulation, because emotional life will always live in increasing refinement, and there will ever be need of a language of signs, so the height of specialization can only end in making every day a holiday indeed. Not that every day will be free from labor, or consecrated to a saint, but that the intricate world of things, of feelings, and of thoughts in which we live, will become so full of ever-present meaning to us that their stimuli will find daily rather than occasional expression, with a single or half-dozen friends instead of a multitude, with shorter hours of labor and longer hours of health, with music rather than with fire-crackers, with ever-thoughtful kindness instead of formal ceremony, and finally with pure and noble daily inspiration for living rather than a funeral pageant.

NEW FACTS IN ALCOHOLIC HEREDITY.

By T. D. CROTHERS, M. D.

SOME years ago I examined two inmates of the Deaf and Dumb Asylum, at Hartford, who from birth had distinct symptoms of acute intoxication. Both were boys, aged nine and thirteen years, who walked with a staggering gait and great muscular incoördination. One had a demented grin, and nodded continuously whenever he saw any one looking at him. The other had a dull, vacant stare, and congested, blear-eyed appearance. He was very irritable, and sensitive to observation, trembling with anger from any little cause. These and many other signs of intoxication were present, and had been noted from birth. The parents of both were inebriates. These cases aroused my attention, and since then I have gathered many notes and histories of similar cases.

Greatly to my surprise, I have found that these cases were not uncommon, especially in asylums and hospitals, and also in active life. Many of them are not so marked, and others require some peculiar conditions or circumstances to bring out these symptoms.

The history of the cases I have obtained may be divided into two classes: one, in which the symptoms of intoxication are present all the time; the other, in which these symptoms only appear from some peculiar circumstances or exciting causes.

In the first class, some prominent defect, such as idiocy, imbecility, and congenital deformity, is present, giving the case a distinctness irrespective of the signs of intoxication. Hence, these symptoms of drunkenness are not separate from other defects in observation. Thus, in a prominent family, one of the children, an imbecile, had all the suspicious hesitancy of manner, also the walk, of a drunkard.

In a private school for the feeble-minded from the wealthier classes, three in fourteen cases had these unmistakable symptoms, which had not attracted attention.

In the home of a former patient I found a little girl, an idiot, whose voice and rambling utterance, with intensely red eyes and drunken expression, pointed back to causes and conditions that had not been noticed before. Other defects and deformities of the face and body cover up these peculiar signs of intoxication.

These symptoms may appear after birth, or be slowly evolved with the growth of the child, coming into prominence at or before puberty.

Of course, all the varied phases of idiocy, imbecility, progressive degeneration, and malformation go on. The presence of a special class of symptoms, resembling intoxication so clearly, suggests a distinct alcoholic causation. In the second class I have noted, the alcoholic symptoms are not present, unless from some exciting cause (non-alcoholic), such as anger, fear, sudden excitement, etc. In this class are idiots, imbeciles, and defectives of all degrees, who at times display distinct signs of intoxication, which subside after a period. Often in these cases appear the common delusions and deliriums of intoxication: also, the semi-paralysis and stupor. Teachers and superintendents of asylums and schools for this class realize clearly the danger of excitement on these dements and defectives, throwing them into various states of mania, as well as intoxication. In one instance, an imbecile boy would become agitated and fall into a state of intoxication if sharply watched, or excited by any cause.

In another case, an imbecile from his birth appears intoxicated when he first meets you, but quickly recovers himself, and all these symptoms pass away. The embarrassment of meeting strangers develops these signs of intoxication. The history of such cases uniformly points to inebriate ancestors. The common explanation of these symptoms is, that this pathological state reflects the condition of one or both parents at the time of conception, or some profound antenatal impression. To support this view the history of the parents gives evidence, and also, in some cases, the peculiar form of intoxication in the parent is seen in the children. Thus, in one case the father, when intoxicated, had a delirium of agitation, in which he moved about incessantly; two idiot children born to him both showed signs of intoxication and had muscular agitation and delirium.

In another case, a woman, when intoxicated, manifested hysterical fear of dogs. She had an imbecile child, which almost went into convulsions at the sight of a dog, and had all the symptoms of intoxication. Numerous instances are on record of profound impressions on the mother's mind leaving a similar impression on the offspring. In one instance an exceedingly nervous lady was greatly frightened by an intoxicated soldier. She gave birth to a boy that had all the signs of intoxication. He lived until twelve years of age, was an imbecile, and had all the marks of a person perpetually intoxicated; he staggered, and would scream out from time to time, without cause or reason. Another case is reported where the mother saw her husband stupidly intoxicated for the first time, and gave birth to an imbecile boy, who was stupid and acted as his father did when poisoned with spirits. It is often difficult to trace these peculiar symptoms, which resemble intoxication, to a similar state in one or both parents at the time of conception; but in most cases the probability of such a state is greatly strengthened by general circumstances and various marks of alcoholic defects and deformities. I find myself forced to conclude that these symptoms are inherited as special pathological states, representing the parents at the time of conception. Why they do not occur in all cases is not clear, but the fact is beyond question that children of inebriates bear marks of defective organization of almost infinite degree, form, and variety.

Beyond this range of cases there is another class, less common, yet with a distinct history and symptoms. Unlike the first class, they are persons who have average brain-power, and in many instances are men of genius and positive force, with a peculiar nerve-organization. They are usually temperate men, never using alcohol, yet under certain circumstances, and from some particular excitement, act and appear as if fully intoxicated.

In these cases some form of mental shock takes place, destroying the normal balance and bringing uppermost an inherited neurotic defect. In some instances alcohol can not be tolerated without producing nausea, vomiting, and extreme depression; and yet from some unknown cause, purely mental, they will suddenly exhibit all the usual signs of intoxication, which pass off as quickly as they came on.

These cases come from inebriate parents or moderate drinkers, and have inherited some defective nerve-organization which manifests itself in this way. I have collected a number of these cases and grouped them under two heads—one of inherited toxic states, and the other of acquired toxic states. In the first class the notes and histories I have gathered will serve as an outline for more exhaustive studies, and they also suggest many new fields of psychological heredity not yet explored. The following are histories of some of these cases:

First Case.—Joseph B——, a farmer of fifty-four, temperate, a man of character and wealth, who had never used any kind of spirits, suffered from a violent shock and alarm from a runaway horse. He was thrown out of the wagon and only slightly bruised, but could not walk after. His face was red, his voice jerking and husky, and his language silly, and he staggered with every appearance of a drunken man. He recovered, but was thought to have used spirits. Some months after, at the funeral of his child, all these and other marked symptoms of intoxication returned, to the great mortification of his friends and family. A year later another similar attack occurred from the burning of some outbuildings on his farm. A careful inquiry made it clear that he had not used any spirits, although he had all the signs except an alcoholic breath. His father was an excessive user of spirits, and his mother died of consumption, but could never tolerate the smell or taste of alcohol. He has been gradually becoming weaker for some years, and is now an imbecile.

Second Case.—The treasurer of a large manufactory, temperate but very nervous, and a hard-working man, of forty-eight, suddenly appeared intoxicated when accused by the president of falsifying the books. He was unable to talk rationally, and both appeared and walked like one who had drunk large quantities of spirits. The next day he recovered, and fully explained, to the satisfaction of all. He was ill for a week, with some general debility and indigestion, then went to his duties, became angry, and had a similar paroxysm. A short time after another attack came on at his house, and the physician called it congestion of the brain. In all these instances no evidence of having taken any spirits could be obtained. His father was a sailor and drank freely.

Third Case.—A merchant, of fifty-eight years, lost all his property in a series of unfortunate speculations. He was much depressed, and went to live with his brother-in-law, a physician. He had been a temperate man from principle, and was in good health up to his failure in business. One day, on the receipt of a letter with bad news concerning some business matters, he became to all appearance intoxicated. His brother-in-law, the physician, made a careful examination of all the facts and surroundings, and concluded that this was a case of what he called mind-intoxication, or drunkenness from causes other than alcohol or drugs. A few weeks later a similar occurrence followed an exciting interview with a creditor. During the two years which preceded his death, three distinct attacks were noted, each one lasting from two to six hours. He died suddenly from pneumonia. His ancestors were both moderate and excessive drinkers.

Fourth Case.—A recent one. A merchant, in good health and temperate, while at work in his counting-room, received a dispatch of the death of his daughter. He lay down on a sofa in his office, and very soon became wildly intoxicated. A physician made this diagnosis, although there was no odor of alcohol in the breath. He was taken home, and remained in bed a week. Two opinions prevailed: one, that he had drunk in his office; the other, that it was congestion of the brain. He denied having used spirits, but was confused about the events of the past. In this case a similar heredity from alcoholic ancestors was present.

These cases are sufficient to illustrate the clinical fact that I am attempting to demonstrate. I am informed by good authority that during the late war many similar cases were noted, and were the subject of much comment and speculation. Thus, men who were total abstainers would, under the excitement of the battle-field, exhibit the wild frenzy of a drunken man or be stupid and largely unconscious of the surroundings. As an illustration, a noted officer at Antietam came riding back from the "front," swaying in his saddle, and shouting parts of songs, in a marked drunken state.

He was a total abstainer, and had not drunk any spirits, but had been at the "front" for hours under great excitement, having a horse shot under him. His conduct was so strange and wild that he was ordered back, under the impression that he was intoxicated. Different surgeons noted this strange frenzied state on many occasions, but in the excitement and change of battle could not ascertain whether it came from the use of spirits or from some mental state. On many occasions it was clear that by no possible ordinary means could spirits be obtained, and yet men previously temperate seemed fully intoxicated. When the battle was over and a degree of relaxation took place, many men would exhibit childish excitement and delirious irritability identical with alcoholic intoxication. At other times, after a period of prolonged strain and excitement, when coffee was given freely, the same inexplicable symptoms of intoxication would appear and be termed "coffee-drunk." When these symptoms appeared at the "front" under fire, they were termed "*battle-drunks.*" Some facts very similar have been noticed in the navy, in the case of gunners, who after a short time of exciting work would become like drunken men and be obliged to go to their berths. This condition has been noticed in persons who were shocked or greatly alarmed at the time of great disasters. A railroad superintendent informed me that on two occasions he had noticed instances of the apparent intoxication of railroad-men who seemed to be at fault through an accident. The intoxication came on after the accident; but from a most careful inquiry he was convinced that they had not used any spirits then or ever, and that their condition was unaccountable.

An incident was related to me by a gentleman, who had been talking quietly in the cars with another man, when they were thrown down a steep embankment. The car-side was broken in, and both were thrown out, only a little bruised. In a few moments one was fully intoxicated. The other, the narrator, could not understand this state or explain it in any way. From these and other statements which I have gathered I conclude that these cases are not infrequent, but, from want of accurate observation and the difficulty of obtaining the facts, they are overlooked. As far as it could be determined, I think that every case had a prominent substratum of direct heredity from inebriate ancestors. In the partial history of some of these cases some form of brain-exhaustion was present, and the shock or paralysis brought to light the special pathological symptoms of alcoholic poisoning. It would be foolish to deny that this was a special nerve and brain defect transmitted from the parents, and only came to light from the action of some particular cause.

In the case of a total abstainer, who, during some state of excitement, manifested all the symptoms of intoxication, where beyond doubt he had not used any form of alcohol, and where inebriety existed in the ancestors, it would be a most reasonable conclusion to infer an origin in heredity, which burst into activity in obedience to some unknown exciting cause. From this point many and varied questions start up, which future observations and studies alone can determine. I think these cases are of the same class as idiots and imbeciles, with special symptoms of alcoholic poisoning, as a direct heredity from the parents; any difference being simply in the fact that these special pathological defects are dormant, but only appear from the action of some peculiar cause. This seemingly represents the conditions of the parents at the time of conception or some antenatal impression. The second class of acquired toxic states have less of mystery, and are more common. They are of the class of men who have been inebriates or intoxicated, and have become total abstainers, but from the same unknown causes suddenly manifest all the old signs of intoxication. Some factor of heredity is present, and possibly some nerve-tracts, along which abnormal energy has been very active in the past, may come into prominence again. An outline of some cases will bring out these facts:

First Case.—The superintendent of a factory, a man who had been temperate and sober for fifteen years, his conduct and character beyond all reproach, was engaged to be married, under circumstances of great promise. The day of the wedding the bride received a letter, warning her against him, saying that he was a secret drinker and a bad man otherwise. This she sent to him by the hand of her brother. After reading it, he showed all the signs of intoxication, and went to bed. The wedding was postponed, and he afterward asserted so positively his innocence that

I was called to give an opinion. An examination indicated that this was some condition of shock, or sudden congestion, in which symptoms of intoxication appeared; also his assertion of not having drunk was literally true. A history of moderate and excessive drinking was noted in his parents.

SECOND CASE.—A clergyman, with a marked history of heredity. He was under my care for five months, when, one day, a brother clergyman paid him a visit, and no doubt talked very severely to him of the sin of drinking. I found him a short time after, in bed, with all the symptoms of intoxication. He had a childish, idiotic expression, and was in a semi-delirious state. He remained in bed two days, and had all the appearance of one who had suffered from alcoholic poisoning. This was the first pronounced case I had seen, and could not be mistaken. The sudden emotional excitement precipitated him into the pathological state of intoxication.

THIRD CASE.—This case was sent to me for an opinion as follows:

A noted temperance lecturer, formerly an inebriate, for ten years or more had been an abstainer. One evening, while lecturing, he was given a dispatch from his wife, announcing the fatal illness of a child. He drank a glass of water, and attempted an explanation to the audience, became confused, staggered, and acted like a man rapidly becoming intoxicated. He was finally led from the stage, and laughed and shouted in a maudlin way. The audience supposed that he was drunk, but all the circumstances showed clearly that no spirits had been taken.

These cases are most strikingly confirmed in many ways, and especially in circles of temperance reformers. One man of my acquaintance, after an eloquent lecture of an hour, during which he most dramatically portrays the conduct and manner of an inebriate, will go to his room and be practically intoxicated for some time, or until he can procure a few hours' sleep. This man has been an inebriate, but for the past five years has been lecturing on inebriety with great power and skill. He has been in the Prohibition campaign, and lectured for months incessantly. These phases of drunkenness are called "queer spells" by his friends, and are guarded from observation. When the lecture is over, he retires at once to his room, and will not be seen until next morning. In another case a man of talent and genius of a high order, who had drunk to great excess for ten years, stopped and became a lecturer. He told me that often the impulse to drink was so strong that he could only resist it by having an audience and opportunity to talk or plead for temperance. He was really intoxicated in his extravagant enthusiasm and dramatic portrayals of the evils of drink. After the lecture was over, he was greatly exhausted and had all the feelings of one who had just suffered from intoxication. The psychological student will find a rare field of study in the temperance meetings of the day, particularly where they are conducted and addressed by reformed inebriates.

These facts are along the line of every day's observation, and are sustained by many collateral evidences. Beyond this are still further ranges of facts, on the same psychological field, less common and more obscure.

A pathological state has been observed, which I call unconscious imitative inebriety, where persons, from the influence or contagion of the surroundings or some unknown factor, are, to all intents and purposes, intoxicated. Here, as elsewhere, a strong substratum of heredity exists. I present the notes of two cases which were sent me by accurate and very competent observers. One, J. H——, was a lawyer, a delicate, nervous man, employed in the State Department, where a monotonous, exact range of duties had been performed for many years. He was unable to use spirits, from the headache it produced. Although his father was an inebriate, he never could or would drink any form of alcohol. He was a society man, and spent his evenings at the club. For several years past it was noticed that, after an hour or more spent in company of men who were drinking to intoxication, he would take on their condition, and like them become intoxicated. He would be with them hilarious or stupid, and use only coffee moderately, while the others drank wine. Sometimes these states would go so far as to make him stupid and unable to walk, and he would need the assistance of a guide and carriage to get home. The next morning he would have a headache. These occasions were at first infrequent, then grew more common, until at present he can not remain an hour in the company of any friend who is intoxicated without appearing and acting like him. He is called by his friends the "coffee-drunkard," for this reason. He will be as stupid as any of them, and yet use nothing but coffee. He would fall into this state more slowly if strangers were present, and sometimes not at all, depending on some internal force that prevented him from giving way. He affirmed that the sensation was very pleasant, and he did not realize his own condition, but was always conscious of enjoyment, until the party broke up and he went home, when a feeling of misery and disgust came over him. The physician who examined him in these states considered that he was a perfect barometer of the mental surroundings, and that after a certain point he gave himself up to a species of mesmeric influence, making him do anything that the others did.

Second Case.—A wealthy farmer and strong temperance man was elected to Congress. He formed a strong attachment for a hard-drinking man in the same body, and, after being in his company for a few hours, would walk and talk like him. He would talk foolishly, and stagger, and act identically like him; but if called away, he soon recovered and was as before, yet in his company he used no spirits, and only occasionally soda. This imitation intoxication grew on him, and he seemed to fall into this state in any drinking party where several were intoxicated. He was not aware of his hilarity or stupidity in drinking company, and only remembered that he could not use spirits. He was reported to be intoxicated in the papers, and could with great difficulty make any defense. He is still in office, but has learned to keep away from all drinking men and state dinners where wine and intoxicated and hilarious drinkers are present. A hereditary taint of both insanity and inebriety was present in his case. I have made another group of these cases, that brings out some facts seen in other circles of life. They are cases of reformed men who show signs of intoxication from the contagion of others who are intoxicants. The following is an example:

A prominent military man, who had drunk moderately during the war, and had abstained from that time on, while attending a dinner with his old comrades, where most of them were intoxicated, suddenly became hilarious, made a foolish speech, and settled back in his chair in a drunken state, and was finally taken home quite stupid. He had not drunk any spirits, and had only used coffee and water, and yet he had all the symptoms of the others, only his was intoxication from contagion—the favoring soil had been prepared long ago in the army. Another case was that of a man who had been an inebriate years ago, but had reformed. He was recently elected to office and gave a dinner to some friends. Among them was a physician, who has been greatly interested in these studies. He sent me a long report, the substance of which was this: On the occasion referred to, many of the company became partially intoxicated, and the host, who drank nothing but water, became hilarious, and finally stupid with them. He was put to bed, with every sign of intoxication, but recovered, and next morning had only a confused notion of these events. The third case occurred four years ago. A reformed man, of twelve years' sobriety, went on a military excursion with a drinking company, and, although he drank nothing but lemonade, became as much intoxicated as the others. This event was the subject of much comment and loss to him, socially and otherwise, although he protested, and others confirmed his statements, that he did not take any spirits at this time.

In these cases, as in the others mentioned, two conditions were present: one, in which some special unknown nerve state was inherited, which readily reflected alcoholic states from contagions;

the other, in which this particular alcoholic state had been acquired, and more readily responded to contagious surroundings than otherwise. In both cases, undoubtedly, heredity was present, but in the latter some previous pathological state existed. What form of brain and nerve defect, and what circumstances and conditions combined to develop this special pathological state must be determined in the future. Along this line are many psychological facts of great interest, that throw light on other mental states. Thus, actors, who essay to represent insanity or inebriety, are successful in proportion as they inherit a nervous organization predisposing them to these affections. A single glass of spirits may awaken a latent nerve defect, and soon after merge into inebriety. So the effort to imitate the manner and conduct of an intoxicated person may give impress and direction to an organism that may be permanent.

An actor, greatly praised for his skill in "Hamlet," was obliged to leave the stage, for the reason that this character was becoming so intimately his as to suggest insanity at an early day. A man who acted the part of a drunken man was, after a time, so completely intoxicated as to be unfit for his part. He could not use spirits, and had to give up this part of the play, for the same reason as mentioned above. A remarkable incident came to my notice along this line. A temperance writer, of great power and vividness of detail, said that he lived all the details of the hero he was describing, in his own mind. When the character was intoxicated, he had all the symptoms, and had to go to bed after writing that the hero did so. He suffered, was exhausted, had pain, mental agony, was joyous, happy, contented, and lived over every event which he described. This man was strictly temperate, but had a drunken father, from whom he inherited a peculiar nervous organization, that gave him power to realize the toxic state from alcohol and throw himself into it more perfectly.

He says that it would impair his health to write more on this theme, for he would be intoxicated most of the time while writing. Many of these states may be termed emotional trance states, and in some future time will be the subject of some very curious and wonderful psychological discoveries. Those who observe inebriates carefully, find them literally encyclopædias of psychological fact, that can not be understood by any present knowledge of the subject. For instance, reformed men, or those who have recently stopped the use of spirits, can not safely listen to a recital of the sufferings and struggles of others to become temperate, without taking on some form of mental shock that is fatal to their own resolutions. The more vivid and accurate the struggles of a drunkard are described, the more certainly the will of the hearer is weakened and rendered impotent to help itself. Temperance lecturers, who hope, by painting the horrors of drink so vividly, to deter any one in the audience from falling in that way, are deceived, and produce the very effect they seek to remedy.

In the same way, the sight of an intoxicated man produces a dangerous form of excitement in the mind of the reformer, and if this should last some time it would react in the same condition. I have embodied many of these curious facts in a paper, with the title of "Mental Contagion in Inebriety," published in the "Alienist and Neurologist" of October, 1884. In this brief glance of the subject I have endeavored to bring out the fact that states of intoxication are found in inebriates and defectives that are marked inheritances from parents. The organism has received a positive permanent impression, from which it never recovers. Also, that this pathological state of acute poisoning from alcohol may be covered up by other defects, and only come out from the application of some peculiar exciting cause. I have called attention to a class of cases, that, from some exciting cause, suddenly become to all appearance intoxicated, although they have not used spirits. An inherited predisposition to this form of defect, from inebriate ancestors, is present in these cases. Also a class of men who have been total abstainers for a long time, who, under similar conditions of excitement, appear intoxicated.

I have described a class of cases where the intoxication was purely from mental contagion, appearing in persons who have been previously drunk, but were temperate at this time. Undoubtedly, conditions of heredity, unknown at present, control and govern this condition. It will be clear from this outline-grouping of facts: (1) that symptoms of alcoholic poisoning can not be trusted as evidence of the immediate use of alcohol; (2) that *the excessive use of alcohol* leaves a permanent defect or impress on the brain, which will go down into the future with great certainty. It may be concealed for a lifetime in the child of a drinking parent, but at any moment may come to the surface, from the application of its special exciting cause; or it may appear in some other form of defect that can be traced back to the injury from the toxic action of alcohol. In brief, the range of facts that open up from this point are truly bewildering, and their discovery and the laws which govern them is the great future realm for investigation.

This grouping of general facts which I have presented, like a preliminary survey in a new country, are merely landmarks for other and more accurate studies.

This is the field into which specialists press forward with increasing enthusiasm, confident that behind all this mystery of drink-craving will be found a majestic order of forces coming from unknown causes, moving in unknown orbits and about unknown centers; also, with equal confidence, that, not far away, inebriety and its evils will be understood, treated, and prevented, as positively as any other disease.

COMMENTS ON THE "SACRIFICE OF EDUCATION."

PROF. F. MAX MÜLLER.

CONSIDERING that nearly forty years ago I did my best to prove the necessity of examinations for admission to the civil service, it will be believed that I did not sign the foregoing protest with a light heart. Before the Indian civil service had been thrown open, and before Sir Charles Trevelyan had carried his reform of the civil service in England, I was allowed by the then editor of the "Times" to publish several letters signed "La Carrière Ouverte," in which I said all that could be said against appointments by patronage and in favor of examinations.

Nor should I wish to withdraw now any of the arguments which I then advanced. I hold as strongly as ever that appointment by patronage is too much for human nature. But I believe the time has come to examine the examinations, to improve them, and to reduce, if possible, the evil which, in addition to much real good, they have produced. The present system of perpetual examination, in spite of all the good which it has done, stands self-condemned, so far as our public schools and universities are concerned, by two facts which can not be contested; viz., (1) the number of men who, after having spent six years at a public school, fail to pass the matriculation examination in college, or the little-go examination in the university; (2) the number of men who, after having taken a degree at Oxford or Cambridge, can not pass the civil-service examinations without spending a year or two with a crammer. These facts speak for themselves. I wish, indeed, that I had time to go fully into the subject, but I have not at present, and I must be satisfied with giving my general impressions, and saying what is uppermost in my mind.

From what I have seen at Oxford and elsewhere, all real joy in study seems to me to have been destroyed by the examinations as now conducted. Young men imagine that all their work has but one object—to enable them to pass the examinations. Every book they have to read, even to the number of pages, is prescribed. No choice is allowed; no time is left to look either right or left. What is the result? The required number of pages is got up under compulsion, therefore grudgingly, and after the examination is over what has been got up is got rid of again like a heavy and useless burden. Nothing is converted *in succum et sanguinem.* The only thing that seems to remain is an intellectual *nausea*—a dislike of the food swallowed under compulsion.

The mischief done is, I believe, most serious. It will poison the best blood of England, if it has not done so already.

It is the best men who suffer most from the system of perpetual examination. The lazy majority has, I believe, been benefited by it, but the vigor of the really clever and ambitious boys has been systematically deadened. Formerly some of my clever young friends were what is called idle at Oxford, but during their hours of idleness, which mostly meant discursive reading and thinking, they grew into something, they became different from others. Now, my young friends seem all alike, all equally excellent, but so excellent that you can hardly tell one from the other. What is the result?

We have excellent members of Parliament, excellent judges, excellent bishops, excellent generals: but if we want to know Who is Who! we must often consult a Red-Book. England is losing its intellectual athletes who were a head and shoulders taller than the rest, and used to be looked up to as born leaders of men. And if history teaches anything, it teaches us that no country remains great without really great men, without a few men different from the rest.

I am asked what remedy there is. In the university there is, I believe, a remedy. Let there be two sets of examinations, one for clever and studious men who promise to take high honors, another for the many. For the latter the examinations might remain what they are now. Only the degrees might be given, not in the name of the university, but in the name of the different colleges. For the former there should be a real matriculation examination held by the university, not, as now, by the colleges; and then, after three or four years, a final examination might follow for real academic honors, allowing great latitude in the subjects of examination.

Much depends in all this on the examiners. In England most examiners are young men, in Germany they are invariably old. The *professores ordinarii,* who alone examine for academic degrees in German universities, try to find out what candidates have learned and know; our young examiners seem chiefly bent on finding out what candidates do not know. Add to this that in some cases, though rarely, examiners are actually the same persons who have crammed their examinees, and it may be imagined how human nature is tried in that process, and what the result must be.

With regard to the civil service, I know no substitute for competitive examinations. Competitive examinations, however, might be toned down to a minimum, and a year of probation might possibly be substituted for the final and decisive examination. I say possibly, for, as is well known, we have always to think of "Take care of Dowb."

Two things seem to me necessary: (1) A careful supervision of examiners. If the examinations are to remain in the hands of the youngest members of the university, their report should always be made, first of all, to the respective faculties, and afterward only, when approved by the faculty, to the vice-chancellor. The necessity of this has been shown by recent experiences in India and elsewhere. (2) A gradual change of competitive into qualifying examinations.

Many years ago we wanted to have examinations for the sake of schools and universities; we now seem to have schools and universities simply and solely for the sake of examinations.

PROF. EDWARD A. FREEMAN.

OF the working of the fashionable fancy for endless examinations, I can speak from direct knowledge only in my own university. Coming back to Oxford, after many years of non-residence, I was perhaps better able to compare what is and what was than either those who have never known anything but the present system or those who have seen the present system grow up. Just now it seems to be understood that examinations are the chief end of life, at any rate of university life; they would seem to be thought to have an *opus operatum* merit for both the examiner and the examined. The object seems to be to multiply examinations as much as possible, to split them up—what is called to "specialize" them—to the extreme point. A man is not, as of old, wholly plucked or wholly passed; with the ingenuity of Italian tyrants, a piece of him is plucked or passed, while the rest of him is kept for the sport of another day. The end steadily kept in view would seem to be that examinations should never cease, that therefore nothing should really be learned, that examinations should follow so fast on one another as just to give time to forget the matter of one examination before the next comes on. The thing has grown to such a height that names can not be found for some of the endless schools, they have to be marked by numbers and letters. The gravest personages will be seen debating with the gravest countenances over some peddling change in "Group A 1," seemingly without the faintest feeling of the grotesque nature of their employment, or of the *reductio ad absurdum* of the whole system which is implied in such a nomenclature, if nomenclature it can be called. The Oxford undergraduate is even examined before he comes into being; the exercise called responsions, the exercise for the now perhaps forgotten *status* of *Generalis Sophista*, is now grotesquely performed on lads not yet members of the university. In natural science, above all, examinations and examiners multiply daily. The luxury, to be sure, is a costly one; it sometimes costs fifty or sixty pounds to examine a single man; but the thing must be done, under pain of loss of character. For in the matter of what is now called "science"—a word which used to have another meaning—the many are in the hands of the few. A proposal for a new examination in any other branch is canvassed, perhaps thrown out, because men have some notion what it means. But "science" is shrouded in mystery. A new -ology is invented; not a dozen persons in the university know what the ology is about; but no one dares to oppose a fresh examination in it, for fear of being called retrograde, obscurantist, opponent of the march of intellect, any other anathema with which the Holy Office of "science" may be ready. And so the thing goes on merrily; everybody is examining or being examined, save during the short intervals allowed for forgetfulness between one examination and another.

Now what has come of all this? Simply the degradation of university learning and teaching into a trade. Each undergraduate seems to do a sum to find out what form of examination may be most profitable to choose—profitable, that is, not to the understanding but to the pocket. I was not a little surprised when, after my return to Oxford, I heard the words "the pecuniary value of a first class." Such words were assuredly never heard in my younger days. A man was rejoiced to get as high a class as he could, both because of the credit of the thing itself and as an augury of a coming fellowship; but he never reckoned the exact value of the class in pounds, shillings, and pence. Another phrase that startled me was that of the "tutorial profession." A college fellow who in my day undertook, most likely for a few years only, the further duties of a college tutor, certainly never thought that he was entering a special "profession." But, owing partly to the growth of examinations, partly to the new position of college fellows which has followed on the fatal permission of marriage, the "tutor," if he can so be called, is now altogether another kind of person. He reaches his fullest modern development in the "combined lecturer," of whom, as he is powerful, one must speak delicately. To him, teaching is strictly a calling; it is a calling and not an office, for he is ready to practice it wherever he can find employment, and he is, moreover, a mere teacher, not discharging any of the other duties of the old college tutor. Without being a university professor or reader, he teaches men from various colleges, but he does nothing except teach them. And he is strongly tempted to teach them a great deal too much, and in the wrong way. When examination after examination becomes the main object, there is sure to be a great deal too much teaching, so much as to leave no time for learning on the part of either teacher or taught. The legitimate duty of a university teacher is to guide his pupil to the right books, the great books of the subject in hand, and to act as a commentator on them. But this implies that the object is, not the passing of an examination, but the study of a subject. When the teacher's business is understood to be to "get a man through" an examination—whether the result of that examination is to be a mere pass or a first class with its "pecuniary value"—study of the subject, study of the great books on the subject, passes away. The teacher puts himself in stead of the books; the thing becomes, in plain words, cram.

This is the *tendency* of the modern fancy for endless examinations. Of course it does not prevail equally in all subjects or with all teachers. It can not prevail so fully with the older subjects, where something of the better tradition of the past is still kept up, as it does with subjects of later introduction. Every man sees his own grievances more clearly than those of his neighbor, and to me it seems that what is called "modern" history is the worst off of all. It is at least worse off than "ancient" history, from which it is so senselessly parted in a separate school, to the great damage of both. For about "ancient" history there still clings something of the traditions of better times, times when men read great books with a tutor instead of filling their note-books with the tips of a crammer. I once asked a man who came to my lectures, "Have you a book?" meaning, in my ignorance, a copy of the author whom we were going to read. He answered, "I have a note-book." That seems to be the net result of forty years' tinkering of everything, of multiplied examinations and multiplied teaching, to drive away "books" and to bring in "note-books." And the professor can do nothing; he can only work away in a corner with a few who are still ready to toil at the text of books, while the combined lecturer flourishes amid a whole library of open note-books. For the professor is useful only to those who seek for knowledge; the combined lecturer, it is fully believed, can guarantee "the pecuniary value of a first class."

Every examination is in itself an evil, as making men read, not for the attainment of knowledge, but for the object of passing the examination, perhaps of compassing its "pecuniary value." But it may be hoping too much to hope that examinations can ever be got rid of altogether. If they must be, then, instead of being many and piecemeal, they should be few and searching. Instead of giving a man time to forget his various subjects one by one, they should make it needful for him to remember his work as a whole. In Oxford we ought to have (1) a matriculation examination; (2) an examination for B. A. much on the lines of the old one before tinkering began about 1849; (3) an examination (or other exercise) for the degree of M. A. of as varied a kind, and, at the same time, of as "specialized" a kind in each case as anybody can want. The complete degree should be given only to those who show real proficiency in some subject, the last "-ology" counting as one. Thus only can real learning, as distinguished from cram, at least cease to be penal. Whether it will ever reach to a "pecuniary value," I do not presume to guess.

May I end with my own personal experience in a time now far distant? I have deeply to thank my Oxford undergraduate course for causing me carefully to read several books, Aristotle's "Ethics" at their head, which I otherwise might not have read at all or might have read less thoroughly. But I do not thank it at all for examining me in anything. I do not mean because I got only a second class; for I got the "pecuniary value" of a first class in the shape of a fellowship. What I do mean is that I read with very little comfort or pleasure, while there was before me the specter of an examination, deadening everything and giving a wrong motive for one's work. When I had got my degree and my fellowship, I said, "Now I will begin really to read." I began in October, 1845, and I have never stopped yet.

Mr. FREDERIC HARRISON.

My point in this discussion is: That, having been called in to aid education, examination has grown and hardened into the master of education. Education is becoming the slave of its own creature and servant. I do not deny that examination has its uses: I do not say that we can do without it. I say that it is a good servant, but a bad master; and, like good servants turned bad masters, it is now bullying, spoiling, and humiliating education.

Those who teach are the proper judges of what should be taught, how it should be taught, and what are the results of teaching. One of the methods by which they have sought to test the results of their own teaching was by examination—one of the methods, an instrument to be used with discretion, moderation, and freedom. This expedient (a mere subordinate expedient) has silently grown into a system; it has perpetually enlarged its own jurisdiction; it has stiffened into a special profession; it has created a body of specialists called examiners. As a body, the class of special examiners are younger men, of less experience, and, except in elementary schools, of inferior learning, as compared with teachers, as a class. They very soon evolve an artificial and professional skill, and set up hard, narrow, technical tests. Their business is not to teach; but to test whether the teachers are teaching, and what the learners are learning. This forces the learners not to attend to their own teachers, but to find some way of satisfying the examiners. Examination papers, not text-books, come to be the real subjects of study; the aim of the student is to get an insight into the mind of his examiner, not that of his teacher; and to master, not the subject of his study, but that artificial skill of passing examinations. Thereupon grew up another class of specialists—the crammers. Their business is, not to teach, nor to test teaching; but to enable students to pass the tests. This soon became an art of its own, as artificial as playing whist or the violin. So, in the cricket-field, having called in professional bowlers to practice, it became necessary to call in professional "coaches" to teach the defense of the wicket. And in the result, education is tending to become a highly exciting match, not so much between the players as between the "bowlers" and the "coaches." The teachers are slowly thrust out and controlled by the examiners; they in turn are checked and dodged at every turn by the crammers: so that learning is fast passing into the grasp of two classes of specialists, neither of whom are teachers, nor pretend to teach.

I have myself had experience both of teaching and of examining for more than thirty years, in more than one university, and in several places of learning. Though not belonging to the special class of examiners, I have constantly been occupied with examining, have worked much with examiners, and have had no small experience of the practical working of the system. I need hardly say that I regard the special examiners as a most acute, energetic, and conscientious body of men; and I say the same of the crammers as a class. Both do their work with great ability and conspicuous honesty. It is not the men, it is the vicious system which is in fault. Every teacher knows by experience that, when he has to take his place in the examination curriculum, he has to submit to the system, and he does his best to practice the examining "art." And when, as every teacher nowadays must, he has to turn crammer, he tries to acquire the crammer's art—*omnes eodem cogimur*. Teachers, examiners, crammers, and students, all have to take their place in the vast examining machine, which, like the Prussian military system, grinds out a uniform pattern. The huge examining mill grinds continually, and grinds very fast—unlike the mills of the gods—but the grain it casts aside; it is designed to grind out the husk.

I do not say that we can do without examinations: nor do I object to all examinations, under any condition. My complaint is confined to the incessant frequency of examinations, the growth of the practice into a highly artificial system, the creation of a profession of examining, and its correlative the profession of cramming, the wholesale, mechanical, and hurried way in which the examinations are held, and the subjection of teaching to examining. In sum, I complain that the trick, the easily acquired and cheaply purchasable trick, of answering printed questions should now so largely take the place of solid knowledge and be officially held out as the end of study.

I shall say nothing about elementary schools. As these are compulsory by law, supported by rates and taxes, and administered by the state and public bodies, and, above all, teach mainly the mere rudiments, there may be reasons for an organized system of examination which do not apply to the higher education. Here the examiners are clearly superior in learning to the teachers; the curriculum itself is more or less mechanical and capable of mechanical tests; and a certain uniformity may be inevitable, and a certain standard of efficiency must be tested. I do not approve of our present system of examining in elementary schools. But I desire to say nothing about it. Nor shall I say anything about the physical effects of overpressure by examination. It is not my subject, and I leave it to others, merely adding, as is plain, that at least nine tenths of any overpressure on students arises from examinations and not from simple study. Nor shall I say anything about official appointments. I have no special theory or plan to support. As a rule, I think people whom we trust to govern must be trusted to select capable agents. If we can not trust them to do this, let us not trust them to govern us. If examinations are required to restrain jobbery, I prefer to deal with the jobbery face to face and by direct means, and not to pervert all public and private education in order to checkmate the wicked jobbers and reward the best crammed ones. Nor am I called upon here to devise a counter-project and to suggest other tests than examination for distinctions and prizes. The distinction and prize system is already absurdly overdone; and nineteen twentieths of the *tests* are wholly needless, or rather actively mischievous. We want neither distinctions, prizes, nor tests in anything like the profusion in which they are now poured out. Art, learning, politics, and amusement are deluged with shows, races, competitions, and prizes. Life is becoming one long scramble of prize-winning and pot-hunting. And examination, stereotyped into a trade, is having the same effect on education that the betting system has on every healthy sport. I do not deny that teachers may usefully examine their own students as a help to their own teaching. I do not say that there may not be one public and formal examination in any prolonged educational curriculum. My plea is against that organized, mechanical, incessant, professional examination, by which education is being distorted, and the spirit of healthy learning is being poisoned.

Examination, like so many other things, is useful as long as it is spontaneous, occasional, and simple. Its mischief begins when it grows to be organized into a trade, and the be-all and end-all of its own sphere. The less the student be "prepared," in the technical sense, the better. The more free the examiner be to use his own discretion with each examinee, the more likely he is to judge him fairly. It was so once. All this is now changed in the thirty or forty years since the examining mania set in. The myriad examinations which now encompass human life have called out an army of trained examiners who have reduced the business to a complicated art as difficult and special as chess. Like chess-playing, the art of examiner and examinee has been wondrously developed by practice. The trained examinee has now learned to play ten examination games blindfold. He can do with ease what the most learned man of the old school could not do. Gibbon would be plucked in the modern history school. Arthur Wellesley would never get into the army. And Burke would have got low marks, through not apportioning his time to the various questions in the paper. I seriously doubt if many of our great scholars, our famous lawyers, historians, and men of science could "floor" off-hand a high-class examination paper. They would not put their knowledge in the sharp, smart, orderly, cocksure style which so much delights the examiner. They would muddle the relation of the *shire-moot* to the *hundred-moot*, or they would forget the point in Smith *vs.* Jones, or they might differ from the examining board as to the exact number of the *isomeric amyl alcohols* now known. All this your trained examinee, well nursed by thorough crammers, has at the tips of his fingers. He "floors" his paper with instinctive knack—seeing at a glance how many minutes he can give to this or that question, which question will "pay" best—and trots out his surface information and his ten-day memory in neat little pellets beautifully docketed off with 1, 2, 3, (α) (β) (γ), the "five elements" of this, the "seven periods" of this movement, and the wonderful discovery (last month) of a new reading by Prof. Wunderbar.

Of course, all this does not take in the examiner. He knows that the student does not know all this, that this is not the wealth of the student's reading, or the product of the student's native genius. But what can he do? His task is to set questions, and the student's task is to answer them. If the questions on paper are answered right, *cadit quæstio*. The examiner's business is not with what the student knows, but with how many questions he can answer, and how many marks he can score. The examiner may see that he is not examining the students so much as the teachers, or perhaps the crammers. All that he can positively say is, that the candidate has been brought to the post perfectly "fit."

The student may be writing down mere "tips" from memory; but if he makes no slip, and he has been carefully crammed, the examiner has to admit that he has got his marks. The examiner may doubt if the knowledge is real, or is worth anything. He can not state that the man has failed. If he had time and opportunity, he could easily ascertain. But in many examinations there is no *viva voce* allowed; in most examinations the public *viva voce* is not thought decisive, owing to nervousness, temper, accident, and various points of temperament and manner. Few examiners now care to decide by *viva voce;* which in any case is done in a hurry and under disturbing conditions that destroy its value as a real test. An examiner has rarely the chance of trying a candidate with a fresh paper, or of giving him as many quiet verbal questions from time to time as he might like. There is no time, there is no opportunity. There are the rigid rules; the candidate is not accessible at the time wanted; he can not be got into a state perfectly composed, easy, and master of himself. A quiet afternoon or a morning's walk would settle it all. But the clock goes round; the machine grinds on; the list must be out in a few hours; the examiners can not sit disputing forever; an average must be struck, time is called, and down goes the candidate's name—usually, be it said, "with the benefit of the doubt."

This is no fault of the examiner. His task is very difficult, trying, and irksome. None but trained men can perform it; and it is wonderful how much trained men can do, and with what patience and conscience they make up their lists. But the higher examiner now has to mark on an average, in a week, from 2,000 to 3,000 answers, perhaps from 4,000 to 5,000 pages of manuscript. In this mass he has to weigh and assess each answer, and to keep each candidate clear in his mind, throughout eight or ten sets of papers. He is lucky if he can do this with less than ten hours per day of work at high pressure—reading in each hour, say, from fifty to a hundred pages of manuscript. He can no more waste an hour, or follow up a thought, than the captain of an Atlantic liner can linger in his ocean-race. The huge engine revolves incessantly; the examiner's mark-sheet slowly fills up hour by hour till it looks like a banker's ledger: some fifty or a hundred candidates get into groups, of Jones, Smith, Brown, etc., or else Nos. 7695, 7696, 7697, etc., and soon Jones, Smith, Brown are labeled for life.

What a farce to call this examination! Any sensible man who wanted to engage a confidential secretary, or a literary assistant, or a man to send on some responsible mission, would not trust to a mark-sheet so mechanical, so hurried. He would see each candidate once or twice alone for an hour or two, talk quietly to him, get him to talk quietly, leave him to write a short piece, set him to do a piece of actual work, try him backward and forward in spontaneous, unexpected ways, as the quality of each candidate seemed to suggest. He would not burden himself with more than four or five candidates at a time. At the end of a week, a sensible man could perfectly make up his mind which of the four or five was the best fitted for the particular work required, and he would almost certainly be right. Nothing of this is possible in the official examination. The "rules" are stricter than those of a prison. There is absolutely no "discretion." Discretion might let in the demon of Favoritism. The candidates are often numbered and ticketed like prisoners, to avoid the disclosure even of names. The precise number of papers is prescribed, and their preposterous multiplication leaves the examiner about one minute for each page of manuscript. With one or two hundred candidates to get through in a week or ten days, the examination is really like the inspection of a regiment. The uniform and accoutrements must conform to the regulation standard.

It is supposed that examiners are masters of the situation and have a large range for a "free hand." It is not so. The examiner's mind runs into grooves, and a highly skilled class have sorted and surveyed the possible field. In each subject or book there are only available, in practice, some few hundreds of possible "questions." The system of publishing examination papers, and close study of the questions over many years, have taught a body of experts to reduce, classify, and tabulate these. So many become stock questions, so many others are excluded as having been set last year, etc.; and in the result a skilled examinee, and still more a skilled crammer, can pick out topics enough to make certain of passing with credit. Knowledge as such, and knowledge to answer papers, are quite different things. Student and examinee read books on quite different plans, if they wish to gain knowledge, or if they are thinking of the examination. The memory is entirely different. The examinee's memory is a ten-day memory, very sharp, clear, methodical for the moment, like the memory cultivated by a busy lawyer, full of dates, of three different courses, of four distinct causes, of five divisions of that, and six phases of the other. It is a memory deliberately trained to carry a quantity of things with sharp edges, in convenient order, for a very short period of time. The feats which the examinee can perform are like the feats of a conjurer with bottles and knives. The examinee himself can not tell how he does it. He acquires a diabolical knack of spotting "questions" in the books he reads. He gains a marvelous *flair* for what will catch the examiner's attention. As he studies subject after subject his eye glances like a vulture on the "points." Examination is a system of "points." What has no "points" can not be examined.

Many able and industrious students do take the trouble to acquire this *flair;* some will not, or can not, acquire it. But certainly a good many acquire it, by an outlay of labor or money, who are neither able nor industrious at all.

A man going through the full school, college, and professional career now passes from ten to twenty of these examinations, at intervals perhaps of six months or a year. From the age of ten till twenty-five he is forever in presence of the mighty mill. The mill is to him money, success, honor, and bread and butter for life. Distinctions and prizes mean money and honor. Success in examinations means distinctions and prizes. And whatever does not mean success in examinations is not education. Parents, governments, schools, colleges, universities, and departments combine to stimulate the competitive examination and the mark-system. None quite like it; but all keep up the tarantula dance—"needs must when the devil drives." The result is that the Frankenstein monster of Examination is becoming the master of education. Students and parents dare not waste time in study which does not directly help toward success in the test. One hears of the ordinary lad at school or college, either as amusing himself because "he is not going in this year," or else as "working up very hard for his examination." He is never simply studying, never acquiring knowledge. He is losing all idea of study, except as "preparation" for examination. He can not burden his memory with what will not "pay." And a subject which carries no "marks," or very few "marks," is almost tabooed. Books are going out of fashion; it is only analyses, summaries, and tables which are studied. But published examination papers are the real Bible of the student of to-day—*nocturna versanda manu, versanda diurna.*

Next to old examination papers, the manuscript "tips" of some famous coach form the grand text-books. One of the ablest men I ever examined, who bitterly complained that he had failed in a coveted distinction, was told that he had not read his books on a given subject. "Why!" he said, indignantly, "he had not read the text-books; but he had mastered a valuable volume of 'tips' in manuscript, which was said to contain every question which could be set in a paper." He failed through pushing the system too far; and a tragedy was the end.

The examination, thus made the "fountain of honor," governs the whole course of study. If the teacher takes up a subject, not obviously grist for the great mill, the students cease to listen, and leave his classes. The instant he says something which sounds like an examination "tip," every ear is erect, every pen takes down his words. The keen student of to-day is getting like the reporter of an evening journal: eager after matter that will tell, will make a good "answer," capital examination "copy." The mill governs the whole period of education, from *hic, hæc, hoc,* to the final launch in a profession. I know little boys of ten, in the *ego et Balbus* stage, who are being ground in printed examination papers which I could not answer myself. And big men, older than Pitt when he governed England, or Hannibal when he commanded armies, are still ruining their constitutions by cramming up "analyses" and manuscript "tips" of great "coaches." The result is that poor little urchins in frocks are in training for some "nursery stakes," as an old friend of mine used to call the trials of preparatory schools. The prize school-boy who sweeps the board on speech-day, often gets a perfect loathing for books, and indeed for any study that is not "cramming"; and the youth who leaves his university, loaded with "honors," may prove to be quite a portent of ignorance and mental babyishness. He has learned the trick of playing with a straight bat the examiner's most artful twisters. But he can not bear the sight of a book; and, like any successful speculator, he has a hearty contempt for knowledge.

Examiners are very clever men; but they ought not to form a sort of Continental "Ministry of Education," controlling on one uniform and mechanical scheme the entire field of education. Examining is more irksome, less continuous, and worse paid than teaching. Hence, as a rule, the professional examiners are hardly men of the same experience, learning, and culture as the professional teachers in the highest grades. They have not devoted themselves to special subjects of study; they do not know the peculiar difficulties and wants of the student; they are not responsible for the interests of a given branch of learning. A body of professional examiners, moving about from great educational centers, tend to give a uniform and regulation character to all learning. Our educational centers are yet in far too chaotic and changing a stage themselves to justify them in stereotyping any system. Knots of clever, eager, trained "experts" in the examining art are being sent about the country from Oxford and Cambridge, marking, questioning, classing, and certifying right and left, on a technical, narrow, mechanical method. They would be far better employed in learning something useful themselves. As it is, they dominate education, high and low. They are like the *missi dominici* of a mediæval king, or the legates *a latere* of a mediæval pope. They pitch the standard and give the word. Public schools revise their *curriculum,* set aside their own teachers, and allow the academic visitor to reverse the order of their own classes. The mill sets a uniform type for the university. Colleges give way and enter for the race. One by one the public schools have to submit, for prizes are the test; and success means prizes. Next, the minor schools and private schools have to follow suit. And at last the smallest preparatory school, where children in nursery-frocks are crying over *qui, quæ, quod,* has to dance the same *tarantela.*

For this state of things the remedies seem to be these: Let examinations be much fewer—they are ten times too numerous. Let them be much more free—they are over-organized, over-regulated. Give examiners more time, more discretion, more room. The more the teachers are themselves the examiners, the better; the less examining becomes a profession and a special staff, the better. Do not set examiners to test teachers as well as students; do not set up mechanical rules whereby to test the examiner. Believe that it is possible to learn without any prize, money, or reward in view. Trust the teacher; trust him to teach, trust him to examine. Trust the examiner, and do not set up a mill. Above all, trust the student. Encourage him to study for the sake of knowledge, for his own sake, and the public good. Cease to present learning to him as a succession of races, where the knowing ones may land both fame and profit.—*Nineteenth Century.*

SKETCH OF JOHN B. STALLO.

JOHN B. STALLO is among the notable examples which this generation presents of men who, while busy in professional and public affairs, have at the same time shown themselves masters in scientific and philosophic thought. His published essays have given him place among the foremost thinkers and critics of his time, while he has achieved an equal eminence in his career of law and politics. In introducing the first of a series of his articles which afterward resulted in the "Concepts," the late Prof. Youmans remarked in the "Monthly" for October, 1873: "It has long been the honor and boast of the British bar that Mr. Justice Grove, the author of 'The Correlation of Forces,' belonged to it; it is equally to the credit of the legal profession in this country that a member of it has cultivated scientific philosophy to such excellent purpose as is proved by the articles we are now publishing."

JOHN BERNARD STALLO is of German origin, and was born at Sierhausen, Oldenburg, March 16, 1823. His ancestors, on both his father's and mother's side, were schoolmasters, and all of them persons of only moderate means. He inherited, particularly from his father's side, a thirst for knowledge and an inclination to scientific studies. These traits were particularly marked in his uncle, Franz Joseph Stallo, who, while a prosperous book printer and binder at Damme, made a number of useful discoveries in physics and mechanics. He is accredited with having introduced peat-burning and the cultivation of buckwheat into his district, and with having promoted the irrigation of the heaths and the sowing of fir-seeds upon them, whereby they were transformed from barren moors into profitable pine-woods. He finally, however, began to advocate views that brought him into conflict with the authorities, and emigrated, followed by a number of his countrymen, in 1831, to the United States, where he attempted to found a colony at a place to which he gave the name of Stallotown, in Auglaize County, Ohio. His career and the prosperity of the colony were cut off, two years afterward, by the ravages of the cholera.

Mr. Stallo's grandfather, an honorable old Friesian, although he had passed his seventieth year when he became his grandson's teacher, took a great interest in the child's development, and rejoiced not a little when he found him, before the end of his fourth year, able to read and to work out simple arithmetical examples. His father gave him particular instruction in mathematics, his favorite study, and took care that he should learn the ancient languages, and French as well—which, out of respect to the old gentleman's national prejudices, had to be taught secretly from the grandfather. In his fifteenth year, young Stallo was sent as a free pupil to the normal school at Vechta, where he also enjoyed the advantage of the instructions of the professors in the gymnasium—an institution in high repute. In a short time he had gained sufficient knowledge of the languages and mathematics to fit him for entrance into the university, but his father had not the means to send him there. The alternative was then presented to him of continuing the chain of schoolmasters in his family, or of emigrating to America. He chose the latter.

He came to this country in 1839, bearing letters of introduction from his father and grandfather to clergymen and teachers in Cincinnati. He at once found a position in a private school in that city, and there he composed and published his first literary work, a German spelling and reading book, which appeared without an author's name. There had been great need of such a book in the lower school classes, and, as this one seemed admirably adapted to its purpose, it soon became popular and passed through many editions. It attracted the attention of the directors of the newly founded Roman Catholic St. Xavier's College, and they, finding also how good a mathematician the author was, appointed Stallo Professor of the German Language, to the duties of which post were added also those of teaching mathematics and the ancient languages. Physical and chemical science being highly esteemed in this institution, and its library being well supplied with books on those subjects, Stallo improved his leisure hours in studying them.

In the fall of 1843 Mr. Stallo became Professor of the Higher Mathematics, Physics, and Chemistry in St. John's College, Fordham, a position which he held till 1847, when he returned to Cincinnati and entered upon the study of the law.

He was admitted to the bar in 1849, and came rapidly into a large practice. In 1853 he was appointed by the Governor of Ohio to fill a vacancy caused by the resignation of Justice Stanley Matthews as judge of the Court of Common Pleas of Hamilton County, and was elected by the people in the same year to that office for the full term. After discharging the duties of this position for two years, with satisfaction to the bar and the public, he resigned it in 1855, in order to continue his more lucrative practice. He thus lived, an eminent and respected citizen of Cincinnati, one of whom the German element especially was proud, prominent in the rational discussion of all questions of public interest, and active in all measures for advancing the public welfare, till, in 1885, he was appointed by President Cleveland to be the diplomatic representative of the United States at the court of the King of Italy.

According to Koerner's "German Element in America," the study of the higher mathematics, in which his professorial positions engaged him, led him logically to the investigation of the German philosophy, and consequently to the cultivation of those habits of thought which are exemplified in his principal published works. The first fruit of these reflections appeared in the book entitled "General Principles of the Philosophy of Nature, with an Outline of some of its Recent Developments among the Germans, embracing the Philosophical Systems of Schelling and Hegel, and Oken's System of Nature," which was published in Boston in 1848.

The credit is given to this publication, by an eminent scientific author, of having marked an epoch in the education of American thinkers. The views then expressed by the author have been modified and in part rejected by his riper experience; but they were not the less full of suggestion and inspiration, giving a new conception of nature, and opening unexplored vistas of thought to the student. This was at a time when the conception of unity and organic plan in nature, though already seen by poets like Goethe, had scarcely entered into the minds of English-speaking students of science. The second part of this early volume of Stallo's was not less welcome to such inquirers from the fact that it included brief expositions of the philosophic views of Kant, of Fichte, and of Schelling, serving as an introduction to a more complete analysis of Hegel's system than had yet appeared in English. To all this was added a carefully digested summary of the physiophilosophy of Lorenz Oken, a work then unknown to most English and American students, although an authorized English translation of it appeared at about the same time, published by the Royal Society, and its views were already influencing the teachings of Richard Owen, of London, then the great master in natural history.

Speaking of this work in the preface to the "Concepts," the author says that it was written when he "was under the spell of Hegel's ontological reveries; at a time when I was barely of age, and still seriously affected with the metaphysical malady which seems to be one of the unavoidable disorders of intellectual infancy. The labor expended in writing it was not, perhaps, wholly wasted, and there are things in it of which I am not ashamed, even at this day; but I sincerely regret its publication, which is in some degree atoned for, I hope, by the contents of the present volume."

A personal friend of the author's describes the book as characterized by an erroneous method, resulting from the passion for freedom in thought and inquiry which was unconsciously its impelling principle—a work composed "in his philosophic heyday, when he tried to turn his conceptions into corresponding facts, to discover truth by creating it."

The work has, nevertheless, left its mark in scientific literature. The direction given by it, both by Stallo's own outline of philosophy and by his introduction to the thoughts of the great German thinkers represented in it, was soon apparent in the writings of several of the new generation of students. In none, perhaps, is this more clearly shown than in the writings of T. Sterry Hunt, whose papers from 1852 bear frequent evidence to the great influence of Stallo's teachings. It is worthy of note that Dr. Hunt's recent work—"A New Basis for Chemistry"—is dedicated to J. B. Stallo, "citizen, jurist, and philosopher," and that the author says in his preface that the volume in question was at that early period a source of inspiration to him.

The results of Judge Stallo's riper thought were given in his second and, so far, his greatest book, "The Concepts and Theories of Modern Physics," a work which at once gave him a worldwide reputation and placed him in the foremost rank among scientific thinkers. The development of the views embodied in this book can be traced, we think, in the author's occasional addresses and his contributions to periodicals in the English and German languages, of which we have only a few at hand; but those few present evident foreshadowings of what was afterward to be given permanent form in the "Concepts." Among them are a paper on "Materialism," contributed apparently as a part of a series of "Philosophical Researches" to the periodical "Atlantis" in 1855; a memorial address on Alexander von Humboldt (1859); the earlier papers of the "Concepts," which were published in "The Popular Science Monthly" in 1873 and 1874; and a "Reply to some Criticisms on the 'Concepts,'" in a later number. In introducing the first of the articles in the "Monthly" (October, 1873), which was on "The Theory of the Atomic Constitution of Matter," the editor of this journal, Prof. E. L. Youmans, said, "The depth and force of the criticism are only equaled by the clearness of the conceptions and the precision and felicity of the statement."

This work is a thoroughgoing criticism of the theories and concepts by which modern scientific philosophy seeks to coordinate the facts of physics, chemistry, and astronomy. In the main this philosophy assumes all phenomena to be reducible to mechanics, and holds that the ultimate elements at which physical analysis arrives are mass and motion; the physical unit being an atom, hard, inelastic, inert, and passive. Since the concept of atoms defines them as absolutely simple, it follows that they must of necessity be equal. Yet here chemistry at once speaks in contradiction, for the atoms, or units, currently so named, differ radically in properties and characteristics. In a review of modern theories of the phases of energy, or modes of motion, we are shown the difficulties which attend the assumption of an ether as the vehicle whereby radiant energy is transferred. From the instantaneous propagation of gravitation through space, it is argued that no medium whatever may be needful for its communication. The kinetic theory of gases is next examined, which theory is shown to involve greater difficulties than it clears up. Next in order the author proceeds to define the conditions of true hypothesis, which in his view should both accord with all known facts and simplify them. He shows how modern theorists have neglected this canon, and supposed they were explaining a fact when they were only dwarfing it, or stating it in new terms. He finds more difficulty in understanding an atom than the mass which it goes to make up.

No portion of the "Concepts" is more striking than its chapter on the relation of thought to things. We are pointed to the fallacy which makes mind the measure of nature, and conceivability the test of truth. The author demonstrates how the historical order in which human knowledge has arisen has largely molded scientific conceptions—for example, in its being supposed that the solid form of matter, the first known and most familiar, is more simple than the gaseous. And because impact is the common mode of propagating motion, ideas as to the propagation of motion universally are curiously limited to the conception of impact. Although the influence of the metaphysics of the middle ages is nominally discarded by modern scientists, yet that influence is distinctly traced in their modern seeking after the absolute in time, space, and motion. This, too, while it is clear that relativity is the law of both nature and thought. Judge Stallo concludes his book with a caustic criticism of the theory that space can exist in more than three dimensions. That theory he shows to involve the attribution to space of the very properties by the absence of which alone it is distinguishable from matter. He avers the search for properties in space, pseudo-sphericity and the like, to be without warrant from physics, mathematics, or logic.

While thus subjecting modern hypotheses to radical and often adverse criticism, Judge Stallo never for a moment drops into an injudicial tone. Such partial and tentative value as these hypotheses may possess he cheerfully accords them, but he maintains that the progress of individual sciences has far outstripped the unifying power of a philosophy whose roots are imbedded in ancient and discredited metaphysics. Throughout his life the themes treated in the "Concepts" have occupied the author's mind, and been the objects of his study. He may in the future present further consideration of the fundamental problems of scientific philosophy, as a sequel to the "Concepts."

It was to be expected that such a volume as the "Concepts" should have a noteworthy reception in the world of science, and at the hands of leading reviewers. Mr. A. W. Reinhold, in the London "Academy," commended it highly. So did "The American Engineer's" critic. Prof. Tait, in "Nature," and the reviewers of the "Critic" and the "Nation," did not admire its analysis, or deem its conclusions sound.

A close friend of Judge Stallo's, who has furnished us with an analysis of his character—Mr. C. H. Goddard, of Marietta, Ohio—credits him with great facility in turning from the study of one thing to the study of another; in learning retentively all kinds of facts, principles, opinions, hypotheses, and words; in analyzing these and using the results of his analyses; and in expression, whether by speech or in writing; "but only an intimate friend," he adds, "could appreciate the seemingly effortless impulse with which he has done the most that he has accomplished outside of his legal practice." He is distinguished among his friends by the breadth of his sympathies, and this is exemplified in many personal and patriotic attachments, and acts growing out of them; in freedom from envy or jealousy, and in the catholicity of his æsthetic tastes; but in nothing more than in his love for knowledge and for rational freedom. Of these, his love for rational freedom is dominant. He has always been ready to leave the search for knowledge to go to the defense of freedom of thought and action, but never to give that up for any other consideration. This trait has been shown publicly in his answer to Orestes A. Brownson's attack upon the Hungarian revolutionists; in his eulogy of Thomas Jefferson as an apostle of the rational freedom of individual men in government; in his speech, after the Republican presidential nomination of 1856, when he urged his fellow-Germans to support Fremont; in his argument against the assumption that our Government is founded upon the Christian religion, as in derogation of the rights of non-Christian citizens; and in many other addresses and in newspaper articles and law cases.

It was also strikingly manifested in his presiding over a public meeting addressed by Wendell Phillips, when the orator was made a mark for missiles, and Judge Stallo stood by his side and bore the brunt of the assault with him. This was in 1862, when Mr. Phillips was invited to speak in Cincinnati in favor of emancipation. A bitter prejudice existed against him because he had been a disunionist. Judge Stallo had been invited to introduce him, but declined, because, his sympathies never having been with Mr. Phillips, he was not the proper man to perform that office. But when he was informed that other men whom he had mentioned as more suitable had declined, because they were afraid of a mob, he consented, saying, "That is enough, gentlemen—I will be there." Mr. Phillips, after being introduced, was at once assailed with a shower of disagreeable and dangerous missiles. One of them hit Judge Stallo. "During the turmoil and uproar," said Judge Stallo, telling the story several years afterward, "Mrs. Stallo, with Mrs. Schneider, sat behind a fellow who had risen and aimed a big stone at the speaker. As he threw his hand back to fire the stone, Mrs. Stallo, who entered heart and soul into the spirit of the hour, and had no thought but to stand by her friends in the stormy crisis, reached over and hit the fellow's wrist a hard blow, making him drop the stone and howl with pain. He looked around to see his assailant, and Mrs. Stallo was up and ready for him, but gentlemen hastened to her side, and the fellow moved away." In the law case of Rothgeb *vs.* Mauck and Others, Judge Stallo maintained the right of an infidel to have a temperately worded declaration of his sentiments recorded upon his tombstone and admitted to the cemetery. In a case in which certain action of the Board of Education of Cincinnati was involved, he opposed the enforcement of the singing of hymns and the reading of the Bible in the public schools, because they were objected to by a part of the citizens who were taxed to support the schools. The reading was enjoined by the local Superior Court, but this decision was overruled by the State Supreme Court.

Judge Stallo's liberality has likewise been exemplified, Mr. Goddard says, "by his political relations, by the ease with which he would change from supporting to opposing, or from opposing to supporting, one of the existing parties, or keep aloof from political action, or help to form a new party, and yet show adhesion to well-rooted convictions." His attitude toward politics is compared in Koerner's "German Element" to that of the tangent to the circle, which only touches it at one place; he has entered the political field as if from without, only on great vital questions, but then works indefatigably in support of what he considers the right views, by word and writing. He was a Democrat till the contest arose over the extension of slavery into the Territories, 1854–1856, through which and through the war he ardently supported the Republican side. He co-operated with the Liberal-Republican movement till Greeley was nominated, when, finding his views on the tariff antagonized by the candidate, he withdrew from its further support. He advocated the election of Tilden and of Cleveland, in the belief that the time had come for a change in administrative policy.

In the days of his life in Cincinnati, Judge Stallo was accustomed to pass his evenings at home, in his library, in social intercourse with his family or such friends as might call in, where he would converse, Mr. Goddard tells us, in English, German, or French, as his interlocutor might prefer, on whatever subject might come up; and with great interest on the discoveries and tendencies in natural science and mathematics, or questions of philosophy, or of political and social interest at home or abroad, or on history and art and literature and men. While not all men could enjoy his favorable opinion, of some he spoke with great reverence, especially of Darwin, whose whole bearing toward truth and toward other scientific men called from him the expression, "I have many heroes, but Darwin is my saint." These conversations were often illuminated by bright flashes of wit, and illustrations drawn from extensive reading; but, whatever his subject or mood, his talk was simple and direct, and marked him versatile and acute, learned and accomplished.

CORRESPONDENCE.

THE FLYING-MACHINE PROBLEM.

Editor Popular Science Monthly:

SIR: To the greater part of Prof. Le Conte's article, "The Problem of a Flying-Machine," in the November number of "The Popular Science Monthly," I give hearty assent, and yet I can not admit that his premises warrant his very discouraging conclusions. He shows clearly that as the animal, flying or walking, increases in size, the ratio between power and weight grows smaller, until finally the limit of muscular strength is reached; or the "weight overtakes the utmost strength of bones to support or muscles to move." He shows that, among mammals, this limit was probably reached in the gigantic dinosaurs; and that the largest flying-birds, such as the turkey-cock and condor, are "evidently near the limit," and that the ostrich and emu have passed it, and hence are unable to fly.

He then speaks of the wonderful efficiency of the animal machine as a means for turning heat into work. "Nerve-energy acting through muscular contraction, and supplied by the combustion of foods, such as oils, fats, starch, sugar, and fibrin, together form the most perfect and efficient engine that we know anything of; i. e., will do more work with the same weight of machinery and fuel. . . . A bird is an incomparable model of a flying-machine. No machine that we may hope to devise, for the same weight of machine, fuel, and directing brain, is half so effective; and yet this machine, thus perfected through infinite ages by a ruthless process of natural selection, reaches its limit of weight at about fifty pounds. . . . The smallest possible weight of a flying-machine with necessary fuel and engineer even without freight or passengers, could not be less than three or four hundred pounds"; and hence Prof. Le Conte concludes that "since the animal machine is far more effective than any we may hope to make, therefore the limit of weight of a successful flying-machine can not be more than fifty pounds," and that a "*true flying-machine, self-raising, self-sustaining, self-propelling, is physically impossible.*"

Can this be so? Is the animal machine more effective than any we can hope to make? Will it necessarily "do more work with the same weight of machinery and fuel"? Does the limit of weight in a flying animal mark the limit for a flying-machine? At the risk of not being considered "a true scientist" I must decidedly dissent from these views; I can not look upon machine-flight as a real impossibility, similar to the production of perpetual motion or of a self-supporting arch of indefinite length.

Before making a comparison between the power of birds and motors, we must get some idea of the power exerted by the former. How much work must a bird of given weight actually do in order to raise himself from the ground and fly? It is well known that, once in the air, the power required is very much less than that necessary for rising. How much less is uncertain, but in a brisk wind an eagle, or condor, or albatross will circle around for hours, hardly ever flapping his wings, and seemingly the only work is that due to muscular effort in keeping the wings outstretched. The work done in getting up is, then, the greatest the bird or machine would be called upon to do. This work will evidently depend upon the ratio of the wing-surface to the weight; with wings only a square foot in area, the most powerful condor could not fly; and the greater the wing-surface, provided the muscles are strong enough to manage it, the less the power required.

This ratio has been measured on many birds. The vulture, for example, can spread 0·82 of a square foot for each pound of weight, and, assuming the entire weight to be thirty pounds, the total wing-surface would be 24·6 square feet.

We now have a ready means for calculating approximately the maximum power such a bird must be able to exert. In order to rise vertically, he must force the air downward until the reaction is equal to his weight. Calling v the velocity of the air in feet per second, R the reaction in pounds, w the weight of a cubic foot of air, A the area of wing-surface in square feet, and g the acceleration due to gravity, we may make use of the well-known formula for reaction: $R = \frac{A w v^2}{g}$ or $v = \sqrt{\frac{R g}{A w}}$, from which, substituting values, we find the necessary velocity to be about twenty-three feet per second. The work done in giving the air this velocity would equal $\frac{R v}{2}$, or three hundred and forty-five foot-pounds per second, equivalent to about six tenths of a horse-power. It is here assumed that the air is driven downward in parallel streams; but a bird's wing would naturally send off a part in other directions, and consequently the power necessary would be somewhat greater. Allowing twenty-five per cent for this and other losses, we see that a vulture weighing thirty pounds would not need to exert more than three quarters of a horse-power, and this only for a few moments while rising.

Suppose, now, our flying-machine to weigh six hundred pounds, or twenty times as much, with the same ratio of wing or propelling surface to weight; we should then require simply twenty times more power, or about fifteen horse-power.

There are, I think, few engineers who will assert such a concentration of power impossible, even when the weight of the man, and fuel for a considerable space of time, are included. Indeed, Strongfellow is said to have, years ago, built an engine and boiler complete which gave a third of a horse-power for a weight of twelve pounds, or weighing only at the rate of five hundred and forty pounds for fifteen horse-power.

Prof. Le Conte shows clearly that with birds "the ratio of weight to strength, and therefore the difficulty of rising, *increases* as the size or weight"; but in a machine it is well known that the above ratio *decreases* as the weight; or, in other words, we can get a hundred horse-power with a much smaller ratio of weight to power than is possible with a single horse-power.

Even now, using iron and steel and steam, we can concentrate power until we can match the energy of a bird; but, by the substitution of aluminum, possessing equal strength and weighing only a third as much as steel, why should we not hope to do much more than that?

Possibly as a heat-engine the animal machine is more efficient than the best steam-engine, although, nowadays, the "Cornish" can hardly be accepted as a standard of excellence; but it seems to me the problem is one of concentration of power, rather than economy. Surely Prof. Le Conte must be mistaken in thinking we can not equal the birds in this respect. He underrates the capacity of our engineers.

The size of a bird is no doubt limited by the strength of bone and muscle, but we are not confined within anything like such narrow limits. The huge dinosaur had reached Nature's limit of size for a walking-machine; but compare him with man's conception—the locomotive—weighing eighty tons and giving out the power of more than eight hundred horses! The whale appears to mark Nature's limit of size in marine animals. Compare him with our ocean-steamers, indicating fifteen thousand horse-power, and propelled by an instrument vastly more efficient than anything Nature has provided!

Why, then, should we be limited in our flying-machine to the weight or size of the largest bird? Surely, if we can produce in it an equal or greater ratio of power to weight, and can command the use of materials strong enough to stand the strain, we are not restricted as to size.

Nor are we limited in a machine to the birds' way of flying. The leverages of the muscles moving the wings are necessarily short and the strains great, but no more than in a steam-vessel are we bound down by Nature's methods. We may very likely be able, in some ways, to improve on her model.

Even were we to admit Prof. Le Conte's claim that the animal machine can "do more work, with the same weight of machinery and fuel," than anything "we may hope to devise," our engineers need not feel discouraged; for the power required in rising from the ground is manifestly much greater than that necessary for flight, and why should we not be able to take advantage of this by starting from some elevated point, and slide down and up aërial inclines after the manner of a bird? He then apparently does not need do a great deal of work, and why should a properly constructed machine?

The problem is a difficult one, but I can not help thinking Prof. Le Conte at fault in placing its solution among the "impossibles." T. W. Mather.

New Haven, Conn., *December* 6, 1888.

DO ANIMALS "PLAY 'POSSUM"?

Editor Popular Science Monthly:

Sir: Walking by a broad ditch, I saw a large, dark-colored snake gliding along the bottom under the water. The creature was coming directly toward me; but as I paused to observe its markings it stopped, raised its head to the surface, and remained motionless. Its back was marked with a pattern of criss-cross curves of pale yellow on a ground-tint precisely like that of water-soaked wood. Presently I began to throw little stones, to make it move on, but it did not stir. Meanwhile, the circles caused by my plashing missiles, the ripple-marks on the sandy bottom, the similar curves on the snake's back, and the crooked, lead-colored neck, all combined to pass off the animal for a water-logged stick. It would have been difficult at that moment to have convinced an inexperienced observer that it was a live snake.

This effect raised the question whether the creature was aware how nearly indistinguishable it had become. It is the common opinion that animals "play 'possum"—i. e., remain passive and apparently helpless under attack—for the purpose of safety, while they are entirely alert and would much prefer to run away. But is this theory credible when we take into account the immense self-control it demands? And can we credit such a seemingly stupid animal as a snake with sufficient intelligence to select deliberately a mode of defense requiring so nice a perception of its own appearance as well as its surroundings? Dr. Abbott thinks that the well-known behavior of the opossum when attacked is due simply to paralyzing fear, and he supports his theory by many careful observations. If it is true that the opossum *faints* with terror in the presence of danger, it seems probable that, in the case of other animals, what looks like intelligent dissimulation is really due to helpless fright. If we human folk are sometimes "too scared to move," why not the lower animals also? S. F. GOODRICH.

GENEVA, OHIO, *September* 5, 1888.

INSECT FERTILIZATION OF FLOWERS.

Editor Popular Science Monthly:

SIR: I have been reading Mr. Grant Allen's very interesting article in the October (1888) number of "The Popular Science Monthly," and, with your permission, I wish to set him right on a few points. On page 732 he says: "A wandering bumble-bee, on dinner intent, poked his long proboscis into pea-flower number one, and, after rifling it of its honey, covered his hairy legs and thighs, half accidentally, with abundant pollen." Why *half* accidentally? The bumble-bee knows nothing about the needs of the pea-family, and when it carries the fertilizer from one blossom to another it does it altogether unconsciously and *wholly* accidentally. Then, again, on page 736, he says: "Now, in the higher plants we get exactly the same sort of combination. . . . If we take any annual plant, like the pea, and look when and where the flowers are produced, we shall see that they come as soon as the plant has attained its full growth, and when the purely vegetative reproductive impulse is beginning to fail." This is not true. The pea begins to blossom at least two weeks before it has its full growth. Many kinds of pea-plants will be as tall again when they begin to decay as they are when they begin to bloom. And it is not the flowers of the pea-vine that use up its strength and cause it to decay, but the maturing and ripening of the seed. Of course, the pollen must strike the pistil at the right time, or no seed is the result, but this pollen does not come in with any reference to the needs of the plant; it comes to answer the needs of the seeds. Again, on page 739, in speaking of the hybrid orchids, he says: "Some wandering bee, visiting a flower of the yellow orchid at this spot where I stood, had carried away on its head gummy pollen-masses, and then, contrary to the common habit of bees (who generally visit only one particular species of plant at a time), had deposited them on the stigma of a neighboring brown specimen. I suppose he was a young and inexperienced insect, who had not yet learned to avoid the bad practice of mixing his honeys. From this chance fertilization any number of hybrids had taken their rise," etc. It is not true that bees only visit one species of plants on each trip. Bees will go from the red to the black-cap raspberry and gather honey from both; and from our sweetest and best grafted apple-trees to the green, bitter, wild crab. Because bees and insects do go helter-skelter among the flowers, we are always budding and grafting, and are never sure of any of our fruits that come from the seed. To prove this, let any one take some flour and stand among the red and black-cap raspberries where they grow close together, when the bees are *roaring* around them; put some flour on a bee's back, and then watch it go from blossom to blossom. I think it must convince the most skeptical of two things: First, that bees work on different species; and, second, that bees know nothing, and care less, about the good of the species.

I say it is *not* true that bees work on the same species while on a trip after honey or pollen. I *claim* much more than this. They work on the flowers of different families. To prove this, go into a garden of flowers during a dearth of nectar and watch the bees go from flower to flower. They will fumble around among the petals of any blossom that contains either pollen or nectar, mechanically and indiscriminately.

Respectfully yours,

MAHALA B. CHADDOCK.

FREMONT, ILL., *November* 27, 1888.

WOMAN SUFFRAGE.

Editor Popular Science Monthly:

MR. CRAMER'S condensed and categorical criticism in your January issue, of my article on this subject, which appeared in the "Monthly" of last October, deserves a reply from me, since his method is direct, and some of the points he raises will bear further ventilation.

First, as to the physical inability of women to take part in the execution of the laws. This I have thought, in common with many other men, to be a sufficient reason why women are not adapted for taking part in government. We are reminded, in reply, that but a portion of the male sex are required to serve in the army, and none beyond the age of forty-five years in this country; and we are told (not for the first time) that, if we disfranchise on this account, we must deprive of the suffrage our most thoughtful class of voters, our older men. This answer is no doubt an honest one, because its refutation is so easy that it would not be brought forward by any one who can see the situation as it is. The situation is simply this: that in all countries, notwithstanding the forty-five-year limit in this one, men will be called on to do military service, when the case requires it, as long as they can walk and carry a gun. Moreover, it is not chiefly as soldiers that men are liable to do duty in the execution of the laws. Any and all men may be called on by the sheriff of the county to serve as *posse comitatus*. Moreover, all our civil government rests on the police and judicial system, and not a single one of the preliminary steps in the process can be performed by women. Not a man could be arrested, taken to prison, taken to the court-room, or to punishment, without a male police. Since women can not act in any of these capacities, nor yet as judges, it is evident that the enactment of laws by women, to be executed by men, is government "by women alone." It was in this sense that I used that expression, and not as a question of arithmetic.

Government is in fact the government *of men by men.* It is men who do things, and, among other things, they are the most frequent law-breakers. It takes men to govern men, and what governs the greater force will control the lesser. It is not necessary to cut two holes in the gate, the one for the large, the other for the small cat. The small cat can go through the large hole.

E. D. Cope.

Philadelphia, *December* 26, 1888.

EDITOR'S TABLE.

ALTRUISM AND EGOISM.

THE question of the proper balance to be maintained between altruism and egoism is one of much practical importance. A certain view of the subject was presented in the paper by Mr. Charles W. Smiley, published in our November number, and a different, to some extent an antagonistic one, was maintained in the letter from Prof. Bulkley, of Washington, which appeared in our number for January. We have already expressed a general approval of Mr. Smiley's position; but, in view of the counter-arguments of our recent correspondent, we may perhaps be allowed a few additional words of explanation.

The question, as it seems to us, is not which is the higher principle of action—altruism or egoism—but the much more practical one as to the extent to which, and the circumstances under which, one human being should gratuitously supplement by his own industry or capacity the deficiencies in one or both these respects of another human being. The early Christians, we read, had all things in common: no one said anything was his own; all individual property was abolished, as completely as P. J. Proudhon himself could have wished. Somehow or other this state of things did not continue long; and Christians of the nineteenth century show no particular desire to revert to this feature of the early church. We may therefore claim that personal ownership of property is recognized to-day as a good thing. If, then, any one is called upon to part with a portion of his goods for the benefit of others, some adequate reason should be shown for his doing so. It is not enough to tell him that altruism is a virtue; for that argument, unchecked by other considerations, would lead to the re-establishment of the very system of communism upon which it has been decided not to re-enter. Before he parts with his money for alleged benevolent objects, a reasonable man will require to have it demonstrated to him that its application in the manner proposed will cure more evil than it will, either directly or indirectly, cause. In order to judge the matter rightly, we should take the case of a man who, possessing wealth, is employing it in a prudent and useful manner, and, so far, helping forward the prosperity of the community; not the case of one who is squandering large sums of money in idle ostentation or vicious pleasures. In the latter case the man is doing harm with his money already, and possibly more harm than would be done even by injudicious benevolence. The former case, therefore, is the only one that enables us to bring a proper criticism to bear upon a suggestion for an "altruistic" application of wealth. The money is now being usefully employed in the industry of the country; and, so far as applied to the personal expenditure of its owner, is being used in maintaining a type of living that simply inspires respect, challenging neither the stupid admiration of the vulgar nor the envious regards of the poorer classes. It is evident that nothing short of a very satisfactory demonstration of the superior usefulness of the proposed end would justify the transfer to it of capital already usefully and worthily employed.

Now, among the points to be considered in weighing such a question, this certainly should not be overlooked, that the altruistic act, while it may alleviate a given case of misfortune, tends to produce another case to replace the one relieved. Does any one ask how? By creating an expectation in the minds of others that their troubles will be lightened or removed in a similar manner, and so causing a certain relaxation of the effort by which a condition of helplessness might be averted. The probability is that not one only but several cases calling for charitable interference might be the result of a single stroke of charitable effort; just as a single prize taken in a lottery upsets scores if not hundreds or thousands of minds. We need not, however, theorize on the subject—though the theory on this occasion is nearly as demonstrable as a proposition in Euclid—for experience has proved over and over again that systematic "charity" makes beggars. The man, therefore, whose money is usefully employed, and who has nothing to reproach himself with on the score of personal waste, will have to be satisfied that the cases of want or vice that he cures—admitting that he cures them—will not be made up, or more than made up, by others resulting more or less directly from his benevolence.

But in how many cases is real good done to the so-called "beneficiaries" of charity? We have ourselves heard the most mournful confessions on this subject from persons who practiced altruism, or Christian charity, as they would perhaps rather have called it, from motives of religious duty. According to these statements, it is a comparatively rare thing to be able to record any solid advantage as resulting to the objects of such charity. But, if so, must not harm result? If we mistake not, the secretaries and other agents of our Young Men's Christian Associations could tell of hordes of shiftless, characterless creatures, interspersed now and then by some unctuous adventurer, who haunt their rooms in the expectation of relief, and who frequently get relief, but of whom no good is ever afterward heard. We do not deny that money may be expended in such a way as to do real good to those who need help; we only say that it is difficult so to expend it, and very difficult to guard against doing harm to others by weakening the motives for resistance to the habits that make for pauperism. Some large charity may seem a beautiful and admirable thing considered in itself; but we should not stop with this inside view. We are bound to ask what effect it is producing on society at large; and if a current is seen ever setting toward it, and virtually "*nulla vestigia retrorsum*"—no steps turned away from it—we must moderate our admiration of the function it is performing in the community.

It is common for sentimentalists to speak of natural selection as the very type of a "merciless law." But who will dare to say with confidence that natural selection is not more merciful, on the whole, than man's vaguely altruistic interferences with the natural course of things? Nature makes incompetence and misery short-lived, and reduces them in every way to a minimum. Man steps in and accuses Nature of cruelty; he tries his own hand, and, lo! thousands and hundreds of thousands are leading a languishing physical and a depraved intellectual and moral existence. The result is not one to be proud of. Man should love his neighbor. Truly; but that does not mean that he should undermine his neighbor's independence, or that he should injure half a dozen neighbors for the sake of benefiting one. As we understand Mr. Smiley, altruism is just as much in need of being kept within the bounds of reason as egoism. He would not discourage generous instincts; but he would oppose the idea that, because an act is altruistic, it must be good and virtuous. All altruism is interference, and interference needs to be justified. As we stated at the outset, people are too much accustomed to think of charity being given out of a surplus that would otherwise not be usefully employed; but that idea tends to disguise the real nature of the question. There is vast need for social reform in the matter of the expenditure of money; and indeed we know of no direction in which a moral crusade is more wanted. If something could be done to check the barbaric extravagance of our wealthy classes and the blamable extravagance of classes that are not wealthy, much good would be done to the whole body of society.

LITERARY NOTICES.

Memory: What it is and how to improve it. By David Kay, F. R. G. S. "International Education Series," Vol. VIII. New York: D. Appleton & Co. Pp. 334. Price, $1.50.

Whatever may be the educational process by which knowledge is gained—observation, reasoning, or passive reception of text-books and lectures—it is retained by the one faculty of memory. This consideration is enough to show the great importance to the educator of a thorough acquaintance with the nature of this faculty and the best means of cultivating it. On the other hand, as Dr. W. T. Harris, the editor of this "Series," points out, the memory, when overdeveloped, may crowd and cramp the other faculties. It is a familiar statement that much memorizing deadens the power of thought, and it is equally true that the powers of sense-perception, imagination, and will may be paralyzed by the same means. "With an overactive memory we suppose ourselves to see in an object what we remember to have seen in it before, and any new features escape our superficial perception. This is true, too, in the case of imagination, the power which ought to be productive as well as reproductive." Hence the problem is not the simple one of how to strengthen the memory as much as possible, but how to train it so that it shall have its greatest efficiency and yet not interfere with the action of the other faculties. As to guarding against an overactive memory, Dr. Harris says: "The antidote for this baneful effect of memory is to be sought in a method of training that associates effects with causes, and individuals with species; that associates one idea with another through its essential relations, and not by its accidental properties. One must put thought into the act of memory." Beginning with an examination of the nature of memory, Mr. Kay proceeds to point out the connection between mind and matter in general, and especially the influence which bodily conditions have upon mental action; he next discusses the phenomena of sensation, and then describes the formation of mental images and the unconscious action of the mind. The author is convinced that much light is thrown upon the subject of mnemonics by the facts of physiology. "When one performs a set of movements," he says, "for the first time, he may find considerable difficulty in doing so, owing to the unadaptedness of the parts concerned. These parts, however, retain certain traces of what has taken place in them, so that when the movements come to be performed a second time the difficulty attending them is somewhat less." Frequent repetition increases the ease of performance. Similarly sensations leave their traces on our sense-organs; men observe best what they have frequently observed. Recalling to mind an act or sensation is so much like the original experience that, in the author's opinion, the same parts are concerned in the one as in the other, and the traces made by these experiences have something to do in the act of recollection. This view is supported by the recent theory that, in the words of Prof. Bain, "the organ of the mind is not the brain by itself; it is the brain, nerves, muscles, organs of sense, viscera." Our ideas are remembered in the same way, for "every idea in the mind must have entered it by some sense, and, in order to its full and complete recall, it is believed that it must be again projected or imaged in an organ of sense. Even the most abstract of our ideas are abstracts of sensations belonging to some sense which is also concerned in the recollection of them." In the concluding chapters Mr. Kay shows that, if the foregoing is true, "it is evident that, in order to improve the memory, special attention must be given to the training of the senses. This is to be done by first training them to observe carefully what is before them, and then making them recall or reproduce what has been presented to them, as accurately as possible. These two are distinct. The one depends on attention, the other on association and frequently recalling what is in the mind. In attention the great thing is to concentrate the mind upon one thing at a time till it is thoroughly mastered. In association we must seek to bring together and associate those ideas that most nearly resemble each other and that we wish to recall each other." The two processes of attention and association are involved in every act of remembering, and suggestions as to how they may be made more effective form the substance of the author's advice on how to improve the memory. Throughout the book the author makes prominent the bearing of his views on education, for he deems the treatment of the memory in the present system of education to be wholly wrong. "Instead of the communication of knowledge," he says, "being made the means of improving the memory, the interests of the memory are sacrificed in order that it may be crammed with as much knowledge as possible, without regard to the permanent injury that may thereby be done to it." The subject is evidently one on which the author has studied long and read widely; his presentation is simple and consistent, and his various statements are supported and illustrated by many brief quotations from eminent specialists in mental science.

Works of Thomas Hill Green. Edited by R. L. Nettleship. Vol. III. Miscellanies and Memoir. London and New York: Longmans, Green & Co. Pp. clxi and 479. Price, $7.

Mr. Green led a quiet life as a tutor and Professor of Moral Philosophy in the University of Oxford, seldom appearing before the public or engaging in movements that brought him into prominence, but he did much work that the world should not let be forgotten while the improvement of mankind and of government is sought. He is characterized by his biographer as a man in whom "philosophy was reconciled with religion on the one side and politics on the other; . . . to whom reason was faith made articulate, and for whom both faith and reason found their highest expression in good citizenship." His thoughts were directed toward practical measures for lifting the English masses into a higher physical and mental condition; and the reading of his essays shows him to have been a man of providential foresight, looking not to the present aspect, but to the remote, not yet seen, result. He was born in a small village in Yorkshire, in 1836, of Puritan descent; was schooled at Rugby, where he showed a tendency toward philosophizing; became a student at Balliol College, Oxford, where he obtained a degree and afterward a fellowship; and then worked as tutor and later (1878 to 1882) as professor. He was one of the "recognized politicians" of the Rugby school, and was considered, in spite of his protestations to the contrary, a "dreadful radical." In college, he made himself felt by his fellow-students, and showed his independence by following his own line of reading rather than pursuing honors and prizes. He regarded Louis Napoleon as a "successful brigand"; had an enthusiastic admiration for John Bright, whom he described as "a great 'brick,' simple as a boy, full of fun, with a very pleasant flow of conversation and lots of good stories"; read Wordsworth, Carlyle, Maurice, and Fichte; failed in the candidacy for a professorship at St. Andrews, Scotland, because he was charged with Comtism and materialism—to which he was really opposed; rejoiced in 1860 over the repeal of the paper-duty, because it would secure the position of the penny papers and destroy the despotism of the "Times"; was comforted with the sure prospect of Gladstone's becoming a radical, for he, Bright, and Cobden would "form a fine triumvirate to lead the people's cause"; and he sympathized ardently with the United States in the war of the rebellion, and saw clearly what was the real issue in the contest. In 1864 he was appointed a member of the Royal Commission on Education, and spent about a year, all told, in industrious personal inspections of the schools of five counties. The remarks in his reports, upon the condition of the schools and the points in which the middle-class schools in particular failed to respond to the needs of those who should attend them, are very pungent, go down to the root of the matter, and look to the final and permanent result; and they show that his strongest sympathies were with the education of the middle classes, whom the universities were only just beginning to touch. This sympathy was intimately bound up with a sympathy with the non-conformists, which was expressed in a lecture before the Edinburgh Philosophical Institution on "Cromwell and the English Commonwealth." He supported electoral reform as a means of redeeming the government from the grasp of capitalists and snobs, and rejoiced over the passage of the conservative bill in 1868, as a victory in which no party was the winner, but the whole nation won "by a measure which makes us for the first time one people." What result was looked for from the enfranchisement of the people was not the present question. "Untie the man's legs, and then it will be time to speculate how he will walk." In one of his speeches he defined as the idea of a true liberal programme "the removal of all obstructions which the law can remove to the free development of English citizens." In a lecture respecting the position of the political reformers, he described them as proceeding "upon the principle that true political freedom means the power on the part of the citizens as a body to make the most and best of themselves, or (which is equivalent) to contribute equally to a common good, and that freedom of contract, freedom in all the forms of doing what one will with one's own, is only valuable as a means to freedom in its positive sense. No contract, then, is valid, which defeats the end for which alone society enforces contracts at all—i. e., that equal development of the faculties of all which is the highest good for all." On this principle he justified interference in matters of labor, health, education, the letting of land, and the sale of alcohol. The strongest elements in his nature "seem to have been the sense of public duty and the sense of religious dependence, and in the creeds of modern liberalism and modern evangelicalism he found a congenial language, which he had no difficulty in translating when he wished into that of German metaphysics. . . . The idea of a free personality, exercising its freedom under conditions which it has itself created, formed the meeting-point for his political and religious aspirations. In the light of this idea he interpreted to himself the problems of history, of morality, of theology." As he grew older, he found that with many of his natural allies, liberal politicians, religious enthusiasts, scientific investigators, he could only go half-way. But, with all modifications in his attitude, "the ideal of Christian citizenship remained his ideal to the end; and, in spite of frequent antagonism to the accredited representatives of physical science, he never relinquished the claim to be at one with the true scientific spirit." The subjects of Mr. Green's lectures, both as tutor and as Professor in Moral Philosophy, turned largely round certain works of Aristotle, to which parts of Plato were added. The manner of treating these works was gradually modified, in accordance with the methods of German commentators and writers like Jowett and Pattison, and became "less literary and more philosophical." The lectures which he delivered during the four years of his professorship were embodied in his "Prolegomena to Ethics," which was published after his death. A course on "Political Obligation" and parts of other courses have been published in the second volume of this edition; and that and the first volume contain the collection of his philosophical works. The present volume of "Miscellanies" contains twenty-one papers, which have been published as public addresses, as articles in the "North British Review" and the "Academy," or through other channels. Among the subjects are "The Force of Circumstances," "The Influence of Civilization on Genius," "The Value and Influence of Works of Fiction in Modern Times," "The Philosophy of Aristotle," "Popular Philosophy in its Relation to Life," "Caird's Philosophy of Religion," "Immortality," "Christian Dogma," "The English Commonwealth," "Liberal Legislation and Freedom of Contract," "The Grading of Secondary Schools," "The Elementary School System of England," "The Work to be done by the Oxford High School for Boys," and theological subjects.

Astronomy with an Opera-Glass. By Garrett P. Serviss. Illustrated. New York: D. Appleton & Co. Pp. 154. Price, $1.50.

Under the above title a series of five articles recently appeared in "The Popular Science Monthly," describing the aspect of the starry heavens as seen through that most available variety of the telescope—the opera-glass. These descriptions included directions for recognizing the constellations and the principal stars, and were illustrated with numerous star-maps and views of the sun and moon, while many allusions to the history and mythology of the subject added to the interest of the text. The articles called forth many lively expressions of pleasure, both from the newspaper press and from individual correspondents, which is not surprising, for the "Monthly" has seldom if ever published a series of papers whose scientific accuracy and fascinating style made them more deserving of the name of popular science than these. The series, rearranged and enlarged, is now published in book form. The volume contains an introduction, composed of matter recast from the articles in the "Monthly," devoted to telling what a good opera-glass is. This is followed by four chapters, devoted respectively to the stars of spring, summer, autumn, and winter, and a chapter on "The Moon, the Planets, and the Sun," the accounts of the planets being new. Throughout the work, and in some parts on almost every page, new matter has been introduced, intended to make the subject clearer and more interesting to the reader, and to render the book enjoyable and useful reading to those who may not care to follow out, opera-glass in hand, the directions and descriptions contained in it. Accounts of additional stars, star-groups, and other objects have been inserted, also fresh references to star-lore, as well as to advances in our knowledge of the heavens made since the series appeared in the magazine. The radiant points of some of the principal meteor-showers have been indicated; also the places in the heavens of the points known as the solstices and equinoxes. Additional descriptions have also been introduced of the revolution of the heavens and its effect upon the places of the constellations at different seasons and different hours. New matter has been added on the history of the Pleiades; about Sirius and Procyon, and their strange companion-stars; and about star-clusters. All the illustrations of the article on "The Stars of Spring" were redrawn and re-engraved for the book, and several new ones have been added in this chapter and in that on "The Moon, the Planets, and the Sun." The volume is printed in large, clear type, on fine paper, and is bound in a notably tasteful and appropriate style.

Microscopical Physiography of the Rock-making Minerals. By H. Rosenbusch. Translated and abridged by Joseph P. Iddings. New York: John Wiley & Sons. Pp. 333. Price, $5.

This work is described by the translator as containing all that is necessary for an accurate and complete determination of the rock-making minerals. In the first part of the volume the optical properties of minerals are described, with some account of their morphological characters, their phenomena of cohesion and chemical properties. In the second or descriptive part the minerals treated are arranged according to their system of crystallization, being divided into two groups, isotropic and anisotropic minerals. The former group comprises amorphous substances and those belonging to the isometric system; the latter group is subdivided into minerals with one optic axis (tetragonal and hexagonal systems), and those with two optic axes (orthorhombic, monoclinic, and triclinic systems). There are, besides these, a few crypto-crystalline substances, which are placed under the head of aggregates. Each section in the first part, and each species in the second, is preceded by a list of the literature of the subject. Twenty-six plates of photo-micrographs and one hundred and twenty-one woodcuts illustrate the text.

Town and Country School Buildings. By E. C. Gardner. New York and Chicago: E. L. Kellogg & Co. Pp. 129. Price, $2.50.

The aim of this work is to aid improvement in a department where improvement has been sadly needed. School-houses have been like barns in the country, and like warehouses in the city, rather than fit places for children to exist and study in. The book comprises a series of twenty-three designs for school-buildings, ranging from a log-house of one room to a brick building of two stories and basement, and containing eight rooms. Each design is accompanied by a general description, in which the lighting, heating, ventilating, and toilet arrangements receive due attention. The text is abundantly illustrated with front and side elevations, floor-plans, and details for doors, fireplaces, transoms, screens, porches, windows, belfries, gates, fences, etc. In all the designs the principle that school-houses should be attractive is insisted on, and their porches with balustrades, the low overhanging roofs, and exterior chimneys of many of them, make the smaller ones look like dwellings, while the large ones have the appearance of libraries or club-houses rather than the severe aspect usually associated with a school-house. Attention is paid to economy withal, especially in the designs for the smaller buildings. The book is very handsomely printed and attractively bound, and deserves a place in the library of every school officer.

Rocks and Soils: Their Origin, Composition, and Characteristics. By Horace E. Stockbridge. New York: John Wiley & Sons. Pp. 239. Price, $2.50.

The object of this book is to present what aid the science of geology can furnish to the important art of agriculture. Some sixty pages are devoted to a sketch of the geological history of the earth, and an equal space to rock composition and decomposition. In this second division, the constituents of the most important crystalline and non-crystalline rocks are given, the disintegration of rocks by internal and by external forces is described, and the products of such disintegration are enumerated. The internal agencies mentioned are volcanoes, thermal waters, rock metamorphism, and contraction of the earth's surface manifested in gradual changes of surface-level, in mountain formation, and in earthquakes. The external forces of disintegration are change of temperature, mechanical and chemical action of water, action of the air, and of organic life. The remaining division of the volume deals with the further transformation of the disintegrated rock into soils by the incorporation of organic matter through the agency of plants and animals, with the constituents and characteristics of soils, and with the soil as related to the production of plants. Methods of experimenting with and analyzing soils are described here. An appendix contains tables of percentages of the constituents found in soils, agricultural products and mineral fertilizers, and these are followed by a list of authorities.

A Manual of the Vertebrate Animals of the Northern United States. By David Starr Jordan. Fifth edition. Chicago: A. C. McClurg & Co. Pp. 375. Price, $2.50.

The object of this manual is to give to students and collectors a ready means of identifying the vertebrate fauna, including marine species, of the region which it covers, and of recognizing the characters on which the families, genera, and species of these animals are founded. A system of analytical keys has been employed by which differential characters are brought into contrast. The present edition is wholly rewritten, and the order of arrangement is reversed, the lowest forms being placed first. The artificial characters largely used in the first four editions of this work for the analyses of the genera have been for the most part replaced by the less obvious characters on which classification is actually based. The region covered by the manual has been extended, so that it now includes the district north and east of the Ozark Mountains, south of the Laurentian Hills in Canada, north of the southern boundary of Virginia, and east of the Missouri River. In order to keep the book of moderate size, all descriptions have been made very concise, while synonymy and generally references to authority have been omitted. Prof. Jordan's name is a sufficient guarantee of the reliability of the work.

The Tariff and its Evils. By John H. Allen. ("Questions of the Day." No. LIII.) New York: G. P. Putnam's Sons. Pp. 122. Price, $1.

In this essay a ship-owner and merchant of long experience combats the theories of the protectionists as formulated by Senator John Sherman in his speech to the Home Market Club of Boston. The author naturally devotes his attention chiefly to the effects of our tariff on our foreign commerce and our carrying-trade, the aspects of the subject with which his experience has made him most familiar. The author maintains that what prosperity we have in this country is obtained from our natural resources and in spite of the protective tariff rather than because of it; that the country is not so prosperous but that we have among us constantly a vast army of workers without work; and that the tariff closes to our products the foreign market, in which we might make large sales. The restrictive system has almost destroyed American shipping, and ship-owners are now looking for contributions from their fellow-citizens in the form of subsidies to enable them to carry on this unprofitable industry. The mill-owners get such contributions, and the ship-owners ask, Why should not we? The farmers, who number about half our working population, and are more than four times as many as the manufacturing workers, suffer severely from a system which protects their products about twenty per cent and taxes them on their purchases nearly seventy per cent. The author's positions are fortified by numerous pertinent facts and figures.

Eating for Strength. By M. L. Holbrook, M. D. New York: M. L. Holbrook & Co. Pp. 236. Price, $1.25.

This book is a popular general guide on the subject of diet, not limited to the case of the athlete, as might be inferred from its title. Its language is simple, and, though scientific reasons are given for its directions, the volume contains nothing that the general reader can not understand. The first hundred pages are devoted mainly to telling the nature and value of the various classes of food-substances which we use, much of the information being arranged in the form of instructive tables. A plea for simplicity in living follows, enforced by the experience of persons who have lived for years wholly or mainly on fruit and vegetables. In the next chapter, the composition and value of each of the chief foods of the vegetable kingdom is set forth, the section on grapes including an account of the grape-cure. Some suggestions follow concerning diet for different ages, circumstances, and a number of specified diseases. The volume contains also several hundred recipes for wholesome foods and drinks, comprising soups, bread, eggs, vegetables, puddings, cake, and even pies, which the author says are wholesome or not as they are well or badly made; also the preparation of tea, coffee, etc., with cautions as to their use, and a variety of beverages from fruit-juices, milk, etc.

The Peter Redpath Museum of McGill University has issued a pamphlet on specimens of *Eozoön Canadense and their Geological and other Relations*, by Sir *J. William Dawson*, F. R. S. (Dawson, Montreal, 50 cents), the purpose of which is stated in these opening lines. "Whatever may be the ultimate decision of palæontologists as to the nature of Eozoön, it is important that the original specimens on which its description was based, and those later acquisitions which have thrown further light on its structure and have been published in that connection, should be preserved and catalogued. The collections made by Sir W. E. Logan are now for the most part in the Museum of the Geological Survey at Ottawa. Those accumulated by the author of these notes, as well as duplicates preserved by Sir W. E. Logan, are in the Peter Redpath Museum. It is to these latter collections that the present paper relates, and the object is to render them as useful as possible for scientific purposes in the future." The pamphlet is not a catalogue, though it contains a synopsis of the specimens to which it relates, but has the form of a monograph, the divisions of which are, geological relations, state of preservation, new facts and special points, notes on peculiar specimens, replies to Möbius, Hahn, etc., palæozoic fossils mineralized with silicates, phosphates, and graphite of the Laurentian, and a summary of arguments in support of the animal nature of eozoön. A bibliography of the subject occupies six pages, and sixteen cuts illustrate the text.

Parts II and III of Vol. II of *The Journal of the College of Science*, Imperial University, Tokio, Japan, have been received. Part II comprises three papers: "On the so-called Crystalline Schists of Chichibu," by Prof. Bundjiro Koto, Ph. D.; "On the Plants of Sulphur Island," by Prof. Samuro

Okubo; and "Some New Cases of the Occurrence of *Bothriocephalus liguloides*, Lt.," by Isao Ijima, Ph. D., and Kentaro Murata. Five plates illustrate these papers. Part III is wholly occupied by an account of "A Magnetic Survey of all Japan," carried out, by order of the President of the Imperial University, by Prof. Cargill G. Knott, D. Sc., and Asst. Prof. Aikitsu Tanakadate. The paper is accompanied by maps showing lines of equal magnetic dip, of equal magnetic horizontal force, of equal magnetic total force, and of equal magnetic declination; also charts of diurnal variation of declination, and two plates representing instruments.

Great-Circle Sailing, by the late *Richard A. Proctor* (Longmans, 35 cents), is a pamphlet "indicating the shortest sea-routes and describing maps for finding them in a few seconds." The routes may be found by the aid of one chart and a few lines of directions, but two charts are more convenient, and a dozen pages of explanation and illustration are given in addition. To meet the difficulty that the true great-circle course would often carry a ship into inconveniently high latitudes, the author gives Mr. Towson's method of composite sailing, which consists in taking a great-circle course to touch the highest latitude deemed safe, then following this parallel to a second great-circle course which passes through the port of arrival. Charts for this mode of sailing, eighteen inches in diameter, reductions of which are given in the pamphlet, may be obtained of the publishers.

We have received from Messrs. Thomas Prosser & Son, New York, *A Sketch of Alfred Krupp*, by *K. W.* and *O. E. Michaelis*, to which is added *A Visit to the Krupp Works at Essen*, from the French of Captain *E. Monthaye*. The sketch makes prominent the sturdy character of the man in forcing his way to success over enormous obstacles. A portrait of Krupp and views of his works are given.

One of the most effective contributions to the literature of tariff reform which has been made during the past year of active discussion is the pamphlet on *Relation of the Tariff to Wages*, by Hon. *David A. Wells*, in the "Questions of the Day Series" (Putnam, 25 cents). Taking as a text a statement by Mr. Blaine about "the condition and recompense of labor in Europe," Mr. Wells proceeds to show in catechetic form that the protectionists who try to work the "pauper-labor" scare "either mean to deceive, or do not know what they are talking about." The scheme of his argument is, first, that the position of labor is more favorable in the United States than in Europe because of the exemption from enormous military and tax burdens, the abundance of fertile land and of means of communication and transportation, the diversity of soil and climate, and the intelligence and energy of the laborers in this country; secondly, that, in proportion to the work done, American laborers do not receive more wages than European; next, that restrictions of markets restrict the opportunities for labor; then, that wages have not been reduced heretofore by reductions in tariff rates; that only five or ten per cent of the bread-winners of the country are engaged in producing protected articles; and, finally, that our present tariff policy is certain to reduce wages. The subject is presented in the clear and vigorous style which marks all of Mr. Wells's economic writings.

The very readable character of the pamphlet by *Henry J. Philpott*, in the "Questions of the Day Series," makes its title, *Tariff Chats* (Putnam, 25 cents), a remarkably fit one. The author points out that the tariff is a tax, and that it favors trusts. He gives figures to show how much it raises the prices of certain woolen, cotton, and iron manufactures, and charges with supreme selfishness the few who are benefited by the tariff at the expense of the many. In a striking table he shows that our wealth, manufactures, wages, and various other interests, advanced far more from 1850 to 1860, under a low tariff, than from 1860 to 1870, or 1870 to 1880, under a high tariff. That the high tariff is not for the farmer's interest is shown by the much lower prices obtained for corn and wheat now than before 1860; and that the wages of the laborers in protected manufactures are governed by something else than the tariff is shown by the very different wages paid in different States of the Union all under the same tariff.

Sharing the Profits, a pamphlet, by *Mary W. Calkins* (Ginn), is a very interesting brief presentation of the subject of participation by employés in the profits of the business in which they are engaged. In the words of the preface, "It is an attempt to state, in the shortest and clearest terms, the theory of profit-sharing, to explain its methods, and to describe its results." A visit by the author to Paris and Guise in 1886 and to Geneva in 1887, in addition to study of the literature of the subject, has furnished the material for this essay. A brief statement of the arguments for profit-sharing is first given; this is followed by descriptions of the ways in which the practice is carried on by a number of concerns in France and neighboring countries; the relation of profit-sharing to pure co-operation, and the aid it may give to industrial reforms, are then pointed out, while in the last chapter certain ethical and economic objections to profit-sharing are answered.

The Union of the Societies for Ethical Culture began with April, 1888, the publication of a quarterly organ, called *The Ethical Record*. The subscription price is $1 a year, and the address of the publication committee is Post-office box 772, Philadelphia. The purpose of the "Record" is to present news of the ethical movement, and articles stating the spirit and aim of ethical culture. The third number, now before us, contains an address by S. B. Weston, Lecturer of the Philadelphia Society, on "The Final Aim of Life," in which Mr. Weston gives reasons for discarding the ancient Greek and the Christian views, and states, as the modern rationalistic idea, that the highest human purpose is "the development of life to its fullest perfection, physically, intellectually, morally." Another paper in the same number is part of an essay on "The Ethics of Insolvency," by Leo G. Rosenblatt. There are also "A Responsive Exercise," in use by the children's classes of the St. Louis Society, a selected poem, several pages of notes, and two pieces of music.

The Agnostic Annual for 1889, which is its sixth number, is edited by *Charles A. Watts* (W. Stewart, London, 6*d.*), and contains eight essays and three poems. The leading article is by Samuel Laing, and is a criticism of the position taken by Mr. Gladstone in his controversy with Colonel Ingersoll. Miss Constance Naden contributes a paper on "The Atrophy of Religion," and Mrs. E. Lynn Linton one on "Women and Agnosticism." The other essays are "Life: the Agnostic Definition," by Albert Simmons; "The Sublimity of Nature," by Charles Watts; "Science and its Detractors," by John Wilson; "Agnosticism among the Moors," by H. J. Hardwicke, M. D.; and "The Aloneness of Man," by G. M. McC.

Ruth, the Christian Scientist, by *John Chester*, M. D., D. D. (Carter & Karrick), is a novel with a purpose, which is to present various theories in regard to the effects of mind in the cure of disease. The doctrine of "Christian Science" is put into the mouth of one character, that of "Faith-Healing" into that of another, while materialism is represented by a young physician, and other characters fill in the background.

In *The Human Mystery in Hamlet* (Fords, Howard, and Hulbert), Mr. *Martin W. Cooke*, attempting "to say an unsaid word," maintains that this great tragedy, far from being a mere play-writer's happy thought, was wrought out, under an inspiration created by the achievements of earlier poets, with a definite end in view. This end was to show in the hero typical man, as he was moved under the force of the interior spiritual struggle of the passions for prevalence, under the domination of supernatural law. His arguments are well considered and forcibly presented, and are strengthened by illustrations from the "Electra" of Euripides and of Sophocles, and Vergil's "Æneid," illustrations which show great resemblance in motive and methods of treatment between Shakespeare and the classical poets.

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POPULAR MISCELLANY.

Faults of City Schools.—In his recent annual report on the public instruction of the State of New York, Superintendent Draper, after mentioning the first-class appliances for education employed in the cities and larger villages of the State, the systematic arrangements and competent superintendence found there, goes on to show the deficiencies of the city schools as follows: "Yet school-work in great cities is encompassed with innumerable perplexities. The conditions of life among the people are widely different in all localities, but these differences are multiplied and intensified in great and thickly settled communities. All classes meet in public schools. The schools are large. The grading and classification of pupils are necessarily close and arbitrary. Individuality disappears, and there is small opportunity to bestow special care upon those personal traits of character and genius which in smaller and less mechanical schools are developed and cultivated so advantageously. The exactions and controversies of politics, unfortunately, encroach more upon the administration of school affairs in large places than in small ones. The people are farther removed from the schools, and they manifest less interest in them because they have less responsibility and power in managing and directing them. It not infrequently happens, also, that the law leaves the granting of appropriations for the extension or even the maintenance of a city school system with the Common Council, or some board which, in either case, was chosen without any reference to the schools, and which seems bound to offset its extravagances in other directions with severe parsimony toward the schools."

Sense of Direction in Insects.—Dr. H. C. McCook has observed a very accurate sense of direction displayed by the "horse-ant" (*Formica rufa*) of Great Britain, in laying out roads from the ant-hills to points in the surrounding woods. These roads or trails had in places a width of from two to four inches, and were distinctly marked upon the surface of the ground, which was stained a dark-brown or black, probably by the formic acid exuded from the insects, and the leaves and grass over which they ran were pressed down and smoothed by the constant passing of innumerable legs. From one large mound three roads ran beneath the tall undergrowth with remarkable directness to different oak-trees in which numerous aphides afforded a food-supply. Road No. 1 was about sixty-five feet in length, and ran in an almost perfectly straight line. No. 2 was about seventy feet long, and varied less than three inches from a direct line measuring from the tree to a point within two feet of the terminal tree. There the trail made a detour of about six inches. No. 3 was a little over one hundred feet in length. A short distance from the nest it touched an old stump which deflected the path at a slight angle, and further on it crossed a foot-path where the travel of the ants was much interfered with by passing human feet. In spite of the difficulties of the track, when the entire trail was staked off, its terminus was found to deviate less than three feet from a straight line drawn from the point of departure.

Australian Message-Sticks.—The descriptions by Mr. A. W. Howitt in the British Association represent a considerable variety as prevailing among the Australian tribes in the use of message-sticks. Some of them are elaborately marked, highly ornamented, and even brightly painted. No messenger known to be such is ever injured. The message-stick is made by the sender and kept by the recipient as a reminder of what he has to do. In one tribe the messenger, for friendly meetings, carries a man's kilt and a woman's apron hung on a reed; but for meetings for hostile purposes, the kilt is hung upon the point of a spear. With a tribe in Victoria, the principal man prepares a message-stick by making certain notches upon it with a knife. The man who is to carry it looks on, and thus learns the connection between the marks on the stick and the message. A notch is made at one end to indicate the sender, and probably notches also for those who join in sending the message. If all the people of a tribe are invited to attend a meeting, the stick is notched from end to end; if part only are invited, only a portion of the stick is notched; and if very few people are invited to meet or referred to in the verbal message, then a notch is made for each person as he is named to the messenger. The messenger carries the stick in a net-bag, and, on arriving at the camp to which he is sent, hands it to the head-man at some place apart from the others, saying, "So-and-so sends you this," and then gives his message, referring, as he does so, to the marks on the message-stick. As a rule, the notches on a message-stick are only reminders to the messenger of the message he is instructed to deliver, and are unintelligible to a man to whom they have not been explained; but certain notches appear to have a definite meaning, and to indicate different classes. Mr. Howitt explained a method for indicating members, which fully disposes of the idea that the paucity of numerals in the language of the Australians arises from any inability to conceive of higher numbers than two, three, or four.

Modern Greek Personifications of the Sun.—According to Mr. J. Theodore Bent, the personifications of the sun among the peasants of modern Greece compare well with the legends of classical times. His beauty, power, and strength endow him with regal attributes, and he is supposed at night-time to seek his kingdom and live in a palace, where his mother tends upon him. We have also the sun's wife and the sun's daughter, and can compare the Macedonian legend of Heliojenni with the Homeric myths of Perse and her children, Circe and Aïetes. The sun, as messenger, may be compared with the words of the dying Ajax. The connection between sun-worship and that of the prophet Elias is very marked in modern Greece. Elias looks after rain, and is the Greek St. Swithin. Churches to him are always found on sites of ancient temples to Apollo. This idea of a union between St. Elias and a power over the elements is clearly shown in a manuscript from Lesbos. There is a connection between sun-worship and St. George, noticeable not only in the islands, but in Macedonia, where a curious swing ceremony is performed on St. George's day in honor of the sun's bride having been swung up to heaven on that day, and the *κάρα* fires are lit.

New Medicinal Plants.—Mrs. H. C. De S. Abbott has published an account of the enterprise of Mr. Thomas Christy, of London, in investigating and introducing the active principles of valuable medicinal plants. His operations are carried on at his estate in Sydenham and in the native countries of the plants, where he has agents employed in collecting and cultivating. One of the most important plants lately introduced is the *Strophanthus*, or arrow-poison of Africa, from which the powerful cardiac remedy strophantine is extracted. The plant is a creeper, topping the tallest trees, and bearing intensely bitter seed-pods. The oily pulp of the seeds, with which the natives smear their arrows, causes instant death, or stupor and foaming at the mouth, followed by death in the animals with whose blood it is mixed, while it does not appear to affect badly the flesh far from the wound. Among other new drugs are kerpod, good for chilblains; alvelos, efficient in skin-diseases; and the haya poison and sassy-bark, which produce anæsthesia of the cornea. Mrs. Abbott suggests that a rich field of research, to be cultivated with great advantage to the healing art, lies in the study of the uninvestigated plants of our own country. It is a field in which she is herself an earnest laborer.

Absence of Memory and Presence of Mind.—The sudden lapses of memory that occasionally attack persons of strong mind are frequently very surprising. Such lapses have occasionally been known to come upon public speakers without the audience seeming to have been aware that the speech had been marred. Thackeray relates that he once lost the thread of an after-dinner speech, and thought that he had made a fool of himself; but his mother, who was within hearing, was of the opposite opinion. The Rev. Henry Ware, of Boston, lost himself in the middle of a sermon and stopped abruptly. He was consoled after the service by hearing one member of the congregation remark to another that that was the best sermon Mr. Ware had ever preached. "That pause was sublime!" A French preacher, when a similar accident befell him, remarked, "Friends, I had forgot to say that a person much afflicted is recommended to your immediate prayers," and knelt down to pray. The afflicted person was himself, and his device was successful to the restoration of the thread of his discourse. A famous Irish actor was once called upon to sing his favorite song, "The Sprig of Shillalah," although it was not on the bills. He could not recollect the beginning, and appealed to the audience: "Ladies and gentlemen, I assure you that I have sung this song so often that I forget the first line!" The audience gave him the first line, and he went on with the song amid great applause. Father Taylor, the "sailor's preacher," when he once got confused, cried out: "Boys, I've lost my nominative case; but never mind, we're on the way to glory!"

British Gold-Mines.—The existence of gold in the British Islands, in quantities perhaps sufficient to pay for modest mining, seems to be established, thereby justifying Strabo's inclusion of the precious metals as among their products. In Wales, gold is found in Carmarthenshire and Merionethshire. At Gogafan, in the former county, are to be seen traces of extensive ancient (probably Roman) workings. At the Viga Cloga Mine, an average annual return of £2,500 was realized from 1860 to 1867, since when the yield has declined. In this mine the vein appears to have been more productive as the working was extended to a greater depth, contrary to what is generally believed about gold-mines. From the Cambrian Mine, 300 ounces, and from the Prince of Wales's Mine, from 300 to 400 ounces of gold have been extracted to the ton of ore. Gold-fields were worked in Ireland at the close of the last century, but operations were stopped in 1802 because the cost exceeded the profit. The attempt was renewed in 1840, but given up again on account of disputes. The principal mining sites were Ballin Valley, Ballintemple, and Killahurler. Gold-fields lie in Lanarkshire and Sutherlandshire in Scotland. They were worked with considerable profit in the days of the Jameses. The gold-field of southeast Sutherlandshire covers an area of thirty miles by twenty. The occurrence of gold in England is rather a matter of speculation; but it exists, and can be found and obtained. Mineral in north Cornwall has assayed eleven ounces to the ton. Mr. J. S. Farrer thinks that the reason no gold-mines are at present being worked in the United Kingdom may lie "far more in the state of the law than in that of the ground."

Children's Punishments.—Something can be said in favor of most of the forms of correction—the rod, strap, tasks, confinement, restriction to plain food, and many others—which have been more or less employed in the school and the family. But there is one which on no account should be employed. Boxing or pulling the ears, or, indeed, striking any part of the head, is most injudicious. Not every form of corporal punishment is so objectionable, but in applying it judgment should be employed. Thus, if a chastisement suitable for a robust child is given to a nervous or feeble one, it will be doubly felt, and will be out of proportion to the offense. Moral means of correction may be the most suitable for sensitive children, and, in the case of school tasks, may possess a certain educational value. There is, however, an important objection to such as imply confinement indoors, especially in cases where the culprit is some poorly nourished youngster to whom fresh air is a luxury, or in any case where the punishment is frequently repeated.

Searching for the Canals of Mars.—In his report at the American Association on the aspect of Mars, as observed at the National Observatory, Washington, Prof. A. Hall said that while observing satellites in April, attempts were made on several nights to see the canals, but without success, and then it was determined to make the trial in twilight, when the observers could see more in detail on the surface of the planet. But nothing like the regular canals drawn by European observers could be seen, although the usual reddish and dark spots and markings were visible nearly every night.

Japanese Mirrors.—The peculiar property of the Japanese "magic mirrors," some of which reflect the figures carved or stamped on their backs, was explained by Prof. Mendenhall, at the American Association. It has been known to the Japanese for a thousand years, but did not receive scientific attention till a few years ago, when a Frenchman studied out the reason of it. The mirrors are round metal disks with short handles covered with bamboo and curiously carved backs. The peculiar thing about them is that, when a ray of light is reflected from their surface upon a screen, instead of a mere blotch of light there appears a reflection of the figures upon the back of the metal. How this is accomplished Prof. Mendenhall explained on the principle of the divergence of rays of light from a convex surface. It has been discovered that the polished surfaces of some of the mirrors are slightly convex. In addition to this, the smooth surface is really irregular, though the irregularity can not be noticed with the naked eye. When the mirror is cast, the cooling process has the effect of drawing it slightly out of shape, and the impress of the ornamentation on the back of the disk gives a practically indistinguishable variation in convexity on the smooth surface that is only noticed when the reflection is cast upon a screen. The mirrors are not made for the "magic" purpose. They are ordinary mirrors, whose magic properties are the result of chance, and not more than one in a thousand possesses them. The author conceives an application of the principle of these mirrors to the realization of the idea of seeing by telegraph, and suggests that, by the use of electro-magnets and selenium, a metal peculiarly sensitive to light-rays, it might be possible to transfer over hundreds or thousands of miles the reflection of letters, or even faces.

Effects of Tile-Draining.—The influence of tile-draining in flood and drought was thus presented by Prof. R. C. Kedzie, in a paper read at the American Association: "1. Surface ditching in conjunction with deforesting may increase floods and contribute to droughts. 2. Tile-draining may increase floods at the "break-up" in the spring, where the waters accumulated in the surface-soil by joint action of frost and soil capillarity during the winter and surface accumulation in form of snow are suddenly set free by a rapid thaw. 3. During the warm months tile-draining tends to mitigate floods by taking up the excessive rainfall and holding it in capillary form, keeping back the sudden flow that would pass over the surface of the soil if not absorbed by it and escape by flood; and also in mitigating summer drought by increasing the capacity of the soil to hold water in capillary form and draw upon the subsoil water-supply by reason of the increasing capillary power of such soil produced by tile-draining."

International Congress of Hydrology and Climatology.—The second triennial session of the International Congress of Hydrology and Climatology is to be held in Paris near the beginning of October, 1889. The President of the Committee on Organization is M. E. Renou, director of the Meteorological Observatory of the Parc de Saint-Maur. The committee has already arranged that the following questions, among others, shall be discussed: Conditions to be observed in the installation of a meteorological observatory; rules for weather-forecasting, and organization of weather-announcements at sanitary stations; climatology of different sanitary stations; comparison and classification of sanitary stations from the point of view of their climatological conditions; on the action of altitude and climates in affections of the lungs; programme of a course of instruction in climatology. Communications should be addressed to the secretary-general, M. Dr. de Rause, Paris, 53 Avenue Montaigne, from the 1st of October to the 1st of June, and at Neris (Allier), from the 1st of June to the 1st of October.

Mineral Evolution.—Dr. T. Sterry Hunt has asserted that "the transformation of the primitive igneous material of this earth's crust through the action of air and water, aided by internal heat, presents a mineralogical evolution not less regular, constant, and definite in its results than the evolution apparent in the organic kingdoms." Continuing the discussion of this subject in the British Association, he shows that the stability of silicated species under atmospheric influence is very variable, some being readily decomposed, and others very permanent; the indifference or chemical resistance, moreover, increasing with the hardness or mechanical resistance. "These two qualities vary for species of analogous constitution directly as their condensation; while, for species of similar condensation and hardness, the chemical indifference increases as alumina takes the place of the ordinary protoxide base, lime, magnesia, ferrous oxide, and alkalies—a fact readily explained by the comparative insolubility of alumina and aluminous silicates in atmospheric waters." Other changes less well known take place in silicates by the subterranean action of watery solutions, when a greater insolubility determines the formation of certain softer hydrated magnesian and aluminous species by epigenesis from harder and more condensed species. Mr. E. A. Ridsdale has spoken of the production and conservation of more stable species as described by Dr. Hunt as a gradual "selection of inert forms," and, further, as "a survival of the most inert." But, "as inertness consists in stability, and in fitness to resist alike the chemical and the mechanical agencies which destroy other species, it is evident that his phraseology is but another statement of the formula of 'the survival of the fittest.' The great principle of the change of the mineral matters which existed in former conditions of our planet, into other forms more stable under the altered conditions of later ages, is but an extension to the mineral kingdom of the laws already recognized in astronomical and biological development."

Training the Emotions.—It has been proposed to give some attention to regulating the development of the emotions, both in the young and in the adult public. Frances Power Cobbe, in the "Fortnightly Review," maintains that emotions come to persons by a sort of contagion far oftener than they spring up of themselves in the human breast. Any attempt to communicate our emotions by command, however, tends rather to produce the opposite feelings. In order to educate the emotions of others, we must employ this natural agency, contagion. In order to inspire a person with a given feeling, we must exhibit the feeling in ourselves. Parents, duly impressed with the importance of the subject, would carefully suppress, or at least conceal, such of their own emotions as they would regret to see caught up by their children. A teacher who has the respect and esteem of his pupils will affect their emotions for evil or good according as he betrays enthusiasm or aversion for selfish and sanguinary conquerors, according as he justifies or condemns assassins and anarchists, according as he represents science as seeking triumphs or truths, and according as he treats efforts for the elevation of mankind with levity or respect. The companions of the young have a great influence on the development of their emotions. As regards girls, their doubly emotional natures make it a matter of moral life and death that their companions should be pure and honorable-minded. Too little precaution is taken, especially in American public schools, against the herding of innocent children with others who have been familiar with vice. As regards the education of the emotions of the community, an excessively demoralizing influence was removed when the public was excluded from executions. Admirable machinery for the communication of noble emotions through the masses is furnished by majestic public functions and by funerals of distinguished men. Literature has an immense power to sway the emotions of all educated people. The stage is another great agency for training the emotions of the public, and, even when it produces only harmless merriment, its influence is wholesome and beneficent. Music and the beauty of nature and of art are also powerful levers of the higher emotions, which it becomes us to use for the benefit of our fellows whenever it is practicable to do so.

The Botanical Outlook.—In his address to the Biological Section of the British Association, Mr. W. T. Thiselton Dyer, while asserting the importance of botany, admitted that the outlook for systematic botany was at present somewhat discouraging. France, Germany, and Austria, he said, "no longer possess anything like a school on the subject, though they still supply able and distinguished workers. That these are, however, few, may be judged from the fact that it is difficult to fill the place of the lamented Eichler in the direction of the Botanic Garden and herbarium at Berlin. Outside of our own country Switzerland is the most important seat of general systematic study, to which three generations of De Candolles have devoted themselves. The most active centers of work at the moment are, however, to be found in our own country, in the United States, and in Russia. And the reason is, in each case, no doubt the same. The enormous area of the earth's surface over which each country holds sway brings to them a vast amount of material which peremptorily demands discussion. . . . The data of systematic botany, when properly discussed, lend themselves to very important generalizations. Perhaps those which are yielded by the study of geographical distribution are of the most general interest. The mantle of vegetation which covers the earth, if only we could rightly unravel its texture, would tell us a good deal about geological history. The study of geological distribution, rightly handled, affords an independent line of attack upon the problem of the past distribution of land and sea. It would probably never afford sufficient data for a complete independent solution of the problem; but it must always be extremely useful as a check upon other methods. Here, however, we are embarrassed by the enormous amount of work which has yet to be accomplished; and, unfortunately, this is not of a kind which can be indefinitely postponed. The old terrestrial order is fast passing away before our eyes. Everywhere the primitive vegetation is disappearing as more and more of the earth's surface is brought into cultivation, or at any rate denuded of its forests. A good deal, however, has been done." Mr. Bentham and Sir Ferdinand Mueller have given a comprehensive flora of Australia, the first large area of the earth's surface of which the vegetation has been completely worked out. Sir Joseph Hooker is busy with the Indo-Malayan flora of the British dominions, and the Dutch botanists have described the Malayan flora proper. British botanists have begun to work the Chinese flora, and the French that of Yunnan. Prof. Bayley Balfour and Dr. Schweinfurth have studied the anomalous flora of Socotra. The flora of Africa has been partly studied, and of this, that of Madagascar is the most interesting. American botanists are still busy with their own flora, and the Russians are continually adding to our knowledge of the flora of Northern and Central Asia. The flora and fauna of Central America have been provided for by the munificence of two English men of science. The flora of Brazil is under slow examination and arrangement in Prof. Urban's "Flora Braziliensis." And the deep-sea exploring expeditions have made known the floras of remote islands.

An Enthusiast in Science.—Prof. W. Stanley Jevons wrote to his sister, from Melbourne, Australia, April 9, 1859: "This afternoon I called at the Melbourne Observatory upon the director, Prof. Neumayer, a rather new-comer. I was introduced to a little spare German, who received me with a tremendous bow, to which I was obliged to respond with interest. . . . With the greatest enthusiasm he at once commenced a complete round of his observatory, showing and discussing with me every instrument, meteorological, magnetic, and astronomical, of which, at least the two former kinds, he had a numerous and very varied collection, all in active use throughout the twenty-four hours. Then he showed me many of the numerical results, explaining the method of reducing them, and carefully taking my direction and name, that he might post me his published reports, and even promising immediately to set his assistants to work to copy out a few barometer readings which I required, and had made the ostensible purpose of my visit. . . . How delightful it is to meet this enthusiasm for true and highly useful things, when one passes whole years together among those who are enthusiastic and greedy only about gold! One would be willingly snubbed each day of the year by the rich and addle-headed, if only received so well as this by the truly best of their race."

Nascent Species of Plants.—Through the discussions of the floras of the western Pacific islands, collected by the Challenger Expedition, we have for the first time been enabled, says the Rev. W. T. Thiselton Dyer, to get some idea how a tropical island was furnished with plants, and to discriminate the littoral element, due to the action of oceanic currents, from the interior forest, almost wholly due to frugivorous birds. The recent examination of Christmas Island by the English Admiralty has shown the process of flora-making in another stage. The plants collected by Mr. Lister prove to be closely allied to those of Java. But the effect of isolation has begun to tell; and it is said by Prof. Oliver that the plants can not be for the most part exactly matched with their congeners from Java, but yet do not differ sufficiently to be specifically distinguished. "We have here, therefore, it appears to me, a manifest case of nascent species."

NOTES.

Prof. Frederick Tuckerman, M. D., of Amherst, has examined two specimens of tape-worm (*Tænia saginata*) of unusual length, sent him by Dr. John G. Stanton, of New London. The first specimen consisted of a long ribbon and several smaller pieces, measuring together over 7 metres, and comprising 711 joints. The head and the neck-joints were not obtained. The second worm had 727 joints, and a length of a little more than 8 metres. Leuckart, the distinguished helminthologist, says, "According to Bremser and Diesing, the famous Viennese collection of helminths contains chains 20 to 24 feet long, very much longer, therefore, than the preserved specimens I have measured, which were at most only slightly above 14 feet." Hence, Prof. Tuckerman's two specimens, of 25 and 27½ feet are remarkable.

Mr. James Constantine Pilling has undertaken the compilation of bibliographies of various North American languages, which are now in course of publication by the Bureau of Ethnology. In preparation for this task he visited the principal public libraries of the United States, Canada, and northern Mexico, corresponded with librarians, missionaries, and other persons interested in the subject, and examined printed authorities. Every effort was made to take titles at first hand, with the result that a very large percentage of the books enrolled are described from the compiler's own sight. The bibliographies of the Eskimo and Siouan languages have been issued, and that of the Iroquois is to follow.

Bathing upon a full meal has long been considered dangerous. The physiological explanation of the peril is, that the blood in digestion tends toward the alimentary tract, leaving the brain proportionately anæmic, and the action of the heart and lungs impeded by a distended stomach. A cold immersion at this stage naturally inducing a tendency to syncope, and concentrating surface blood still more about the central organs, the heart finds the labor imposed upon it too great, and finally succumbs.

The make of American salt, it is said, has more than doubled during the last ten years. Within the same period two new salt regions have enjoyed a rapid development. According to the "Saginaw Courier," 3,944,309 barrels of salt were made in Michigan in 1887, against 2,673,588 in 1880, and 561,288 barrels in 1869. More salt was made in Michigan in 1887 than had been made in all the time previous to 1869. A strong rival to the Onondaga district has been developed in the Wyoming region of western New York, where a most extensive salt-manufacture has grown up within the last five or six years.

There are still, according to the Rev. J. Batchelor, prophets and prophetesses among the Ainos, but they limit their powers to telling the cause of illness, prescribing medicine, using charms, and the like. The person prophesying is supposed to sleep or otherwise lose consciousness, and not to know what he is uttering. The burden of the prophecy sometimes comes out in jerks, but more often in a kind of sing-song monotone.

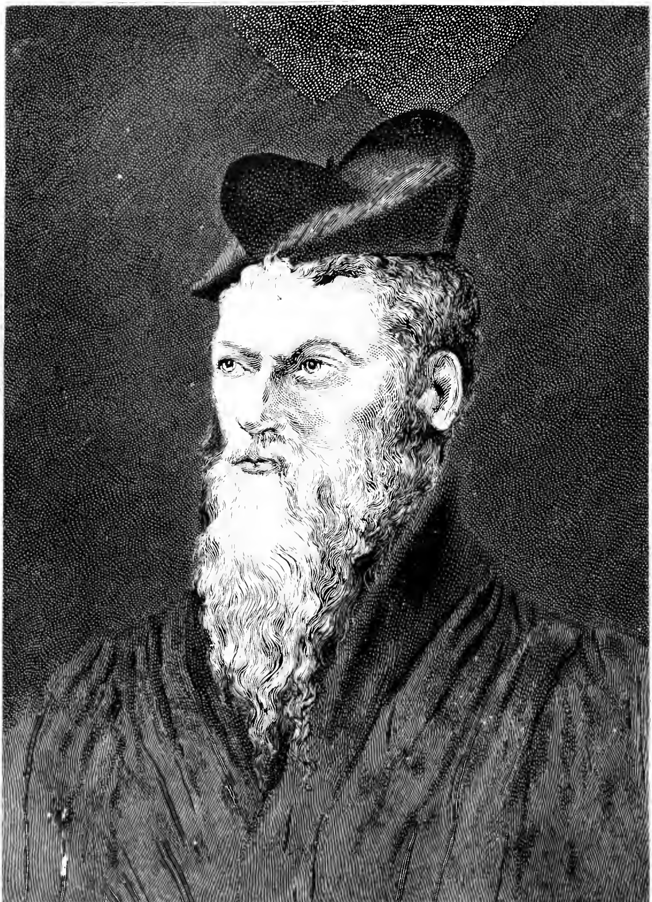
A dexterous management of the roller-shades of windows may be made to go a great way in promoting the coolness of rooms. Let the upper window-sash be lowered, and the inside blind or curtain placed outside and secured in position by passing its tassel-cord beneath the lower sash. Thus the window-glass is protected from the direct rays of the sun, and is at the same time cooled by the current of air that passes between the blind and window. An additional merit of the plan is that it promotes ventilation.

While the value of kindness in discipline can hardly be overestimated, it must be admitted that suasion alone will not avail for every instance in which a pupil's will is idle or obstinate. Boys are well aware of this, and are apt to look for something more as constituting an authority worthy of obedience. Hence, it is argued by experts in training that it is unwise, and in the end unkind, always to spare the rod. But all striking at random must be condemned, and particularly such barbarity as boxing the head and ears. Nature has furnished a part, well cushioned, but sensitive enough, well adapted to the exercise of chastisement, upon which any punishment within reason will fall harmless.

Annatto thrives in Guadeloupe at heights of from 1,500 to 2,000 feet above the sea, while greater heights are progressively more unfavorable to it. The seeds are planted in holes prepared to receive them, or in nurseries, and the young plants require most careful attention during the first year; but afterward they grow fast and need but little care. A few pods may be gathered in one year after the plant has been transferred from the nurseries. Annatto bears twice a year, the spring blossoms always yielding the largest crop. As soon as the pods in the bunches begin to dry and open, the bunches are cut, packed in baskets, and carried to the shed prepared for the purpose. The picking of the pods is very tedious.

Two French gentlemen are constructing a terrestrial globe for the exposition of 1889, on the scale of one millionth. It will be thirteen metres in diameter and forty metres in circumference, and a kilometre will be represented on it by a millimetre. Paris will occupy a space of about a square centimetre. It is believed that the contemplation of this object, whose size is a measurable fraction of that of the earth, will help, better than any other existing apparatus, to convey a realization of terrestrial magnitudes and distances.

An attempt last year to cultivate the cotton-tree near Taganrog, on the Don, in European Russia, is said to have proved successful.



PIERRE BELON.

THE

POPULAR SCIENCE MONTHLY.

MARCH, 1889.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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"DEMONIACAL POSSESSION" AND INSANITY.

PART II.

IN the foregoing chapter we have seen the culmination of the old procedure regarding insanity, as it was developed under theology and enforced by ecclesiasticism; and we have noted how, under the influence of Luther and Calvin, the Reformation rather deepened than weakened the faith in the malice and power of a personal devil. Nor was this in the reformed churches, any more than in the old, mere matter of theory. As, in the early centuries of Christianity, it was to their power over the enemy of mankind in the bodies of men that the priests of the new faith especially appealed in proof of its divine origin and nature, so now the clergy of the rival creeds eagerly sought opportunities to establish the truth of their own doctrines and the falsehood of their opponents' by the visible casting out of devils. True, their methods somewhat differed: where the Catholic used holy water and consecrated wax, the Protestant was content with texts of Scripture and importunate prayer; but the supplementary physical annoyance of the indwelling demon did not greatly vary. Sharp was the competition for the unhappy objects of treatment. Each side, of course, stoutly denied all efficacy to its adversaries' efforts, urging that any seeming victory over Satan was due not to the defeat but to the collusion of the fiend. As, according to the Master himself, "no man can by Beelzebub cast out devils," the patient was now in greater need of relief than before; and more than one poor victim had to bear alternately Lutheran, Romish, and perhaps Calvinistic exorcism.*

But far more serious in its consequences was another rivalry to which in the sixteenth century the clergy of all creeds found themselves subject. The revival of the science of medicine, under the impulse of the new study of antiquity, suddenly bade fair to take out of the hands of the Church the profession of which she had enjoyed so long and so profitable a monopoly. Only one class of diseases remained unquestionably hers—those which were still admitted to be due to the direct personal interference of Satan—and foremost among these was insanity.† It was surely no wonder that an age of religious controversy and excitement should have been exceptionally prolific in ailments of the mind; and to men who mutually taught the utter futility of that baptismal exorcism by which the babes of their misguided neighbors were made to renounce the Devil and his works, it ought not to have seemed strange that his victims now became more numerous.‡ But so simple an explanation did not satisfy these physicians of souls, or, rather, they devised a simpler one: their patients, they alleged, were bewitched, and their increase was due to the growing numbers of those human allies of Satan known as witches.

Already, before the close of the fifteenth century, Pope Innocent VIII had issued the startling bull by which he called on the archbishops, bishops, and other clergy of Germany to join hands with his inquisitors in rooting out these willing bond-servants of Satan, who were said to swarm throughout all that country, and to revel in the blackest crimes. A half-dozen popes had since reiterated the appeal; and, though none of these documents touched on the blame of witchcraft for diabolic possession, the inquisitors charged with their execution pointed it out most clearly in their infamous hand-book, the "Witch-Hammer," and prescribed the special means by which possession thus caused should be met. These teachings took firm root in religious minds everywhere; and, during the great age of witch-burning that followed the Reformation—when, in Germany alone, according to the most

* For instances of this competition, see Freytag, "Aus dem. Jahrh. d. Reformation," pp. 359–375. The Jesuit Stengel, in his "De judiciis divinis" (Ingolstadt, 1651), devotes a whole chapter to an exorcism, by the great Canisius, of a spirit that had baffled Protestant conjuration. Among the most jubilant Catholic satires of the time are those exulting in Luther's own alleged failure as an exorcist.

† For the attitude of the Catholic clergy, the best sources are the confidential Jesuit "Litteræ Annuæ." To this day the numerous treatises on "pastoral medicine" in use in the older Church devote themselves mainly to this sort of warfare with the devil.

‡ Baptismal exorcism continued in use among the Lutherans till in the eighteenth century, though the struggle over its abandonment had been long and sharp. See Krafft, "Historie vom Exorcismo" (Hamburg, 1750).

moderate estimate, there perished within a single century (1550–1650) by an excruciating death, for this imaginary crime, not less than a hundred thousand human lives—it may well be doubted whether any single cause so often gave rise to an outbreak of the persecution as the alleged bewitchment of some poor mad or foolish or hysterical creature. The persecution thus once under way, it fed itself; for, under the terrible doctrine of "excepted cases," by which in the religious crimes of heresy and witchcraft there was no limit to the use of torture, the witch was forced to confess to accomplices, who in turn accused others, and so on to the end of the chapter.*

The horrors of such a persecution, with the consciousness of an ever-present devil it breathed and the panic terror of him it inspired, could not but itself increase the insanity it claimed to avenge. Well-authenticated, though rarer than is often believed, were the cases where crazed women voluntarily accused themselves of the impossible crime; and one of the most eminent authorities on diseases of the mind declares that among the unfortunate beings who were put to death for witchcraft he recognizes well-marked victims of cerebral disorders; while an equally eminent authority in Germany tells us that, in a most careful study of the original records of their trials by torture, he has often found their answers and recorded conversations exactly like those familiar to him in our modern lunatic asylums, and names some forms of insanity which constantly and unmistakably appear among those who suffered for criminal dealings with the Devil.†

The result of this wide-spread terror was naturally a steady increase in mental disorders. A great modern authority tells us that, although modern civilization tends to increase insanity, the number of lunatics at present is far less than in those ages of faith and in the Reformation period. The treatment of the "possessed," as we find it laid down in standard treatises, sanctioned by orthodox churchmen and jurists, accounts for this abundantly.

* For a much fuller treatment of this phase of the subject, I must refer the reader to my chapter on witchcraft. The Jesuit Stengel, professor at Ingolstadt, who (in his great work, "De judiciis divinis") urges, as reasons why a merciful God permits illness, his wish to glorify himself through the miracles wrought by his Church, and his desire to test the faith of men by letting them choose between the holy aid of the Church and the illicit resort to medicine, declares that there is a difference between simple possession and that brought by bewitchment, and that the latter is the more difficult to treat.

† See D. H. Tuke, "Chapters in the History of the Insane in the British Isles," London, 1882, p. 36; also Kirchhoff, p. 340. The forms of insanity especially mentioned are "dementia senilis" and epilepsy. A striking case of voluntary confession of witchcraft by a woman who lived to recover from the delusion is narrated in great detail by Reginald Scot, in his "Discovery of Witchcraft," London, 1584. It is, alas, only too likely that the "strangeness" caused by slight and unrecognized mania led often to the accusation of witchcraft instead of to the suspicion of possession.

One sort of treatment used for those accused of witchcraft will also serve to show this—the "*tortura insomniæ.*" Of all things in brain-disease, calm and regular sleep is most certainly beneficial; yet, under this practice, these half-crazed creatures were prevented, night after night and day after day, from sleeping or even resting. In this way temporary delusion became chronic insanity, mild cases violent, torture and death ensued, and the "ways of God to man" were justified.*

But the most contemptible creatures in all those centuries were the physicians who took sides with religious orthodoxy. While we have on the side of truth a Flade sacrificing his life, a Loos his hopes of preferment, a Bekker his position, and a Thomasius his ease, reputation, and friends, we find, as allies of the other side, a troop of eminently respectable doctors mixing Scripture, metaphysics, and pretended observations to support the "safe side" and to deprecate interference with the existing superstition, which seemed to them "a very safe belief to be held by the common people." †

Against one form of insanity both religions were especially cruel. Nothing is more common in all times of religious excitement than strange personal hallucinations, involving the belief, on the part of the insane patient, that he is a divine person: in the most striking representation of insanity that has ever been made, Kaulbach shows, at the center of his wonderful group, a patient drawing attention to himself as the Saviour of the world.

Sometimes, when this form of disease took a milder hysterical character, the subject of it was treated with reverence, and even elevated to sainthood: such examples as St. Francis of Assisi and St. Catherine of Siena in Italy, St. Bridget in Sweden, St. Theresa in Spain, St. Mary Alacoque in France, and Louise Lateau in Belgium, are typical. But more frequently such cases shocked public feeling, and were treated with especial rigor: typical of this is the case of Simon Marin, who in his insanity believed himself to be the Son of God, and was on that account burned alive at Paris and his ashes scattered to the winds.‡

* See Kirchhoff, as above.

† For names and arguments used by creatures of this sort, see Diefenbach, "Der Hexenwahn vor und nach der Glaubensspaltung in Deutschland," pp. 342–346. A long list of these infamous names is given on p. 345.

‡ As to the frequency among the insane of this form of belief, see Calmeil, ii, 257; also Maudsley, "Pathology of Mind," pp. 201, 202, and 418–424; also Rambaud, "Histoire de la Civilisation en France," ii, 110. For the peculiar aberrations of the saints above named and other ecstatics, see Maudsley, as above, pp. 71, 72, and 149, 150. Maudsley's chapters on this and cognate subjects are certainly among the most valuable contributions to modern thought. For a discussion of the most recent case, see Warlomont, "Louise Lateau," Paris, 1875.

The profundity of theologians and jurists constantly developed new theories as to the modes of diabolic entrance into the "possessed." One such theory was that Satan could be taken into the mouth with one's food—perhaps in the form of an insect swallowed on a leaf of salad. Another theory was that Satan entered the body when the mouth was opened to breathe, and there are well-authenticated cases of doctors and divines who, when casting out evil spirits, took especial care lest the imp might jump into their own mouths from the mouth of the patient. Another theory was that the devil entered human beings during sleep; and, at a comparatively recent period, the King of Spain was wont to sleep between two monks, to keep off the devil.*

The monasteries were frequent sources of that form of mental disease which was supposed to be caused by bewitchment. From the earliest period it is evident that monastic life tended to develop insanity. Such cases as those of St. Anthony and St. Augustine are typical of its effects upon the strongest minds; but it was especially the convents for women that became the great breeding-beds of this disease. Among the large numbers of women and girls thus assembled, many of them forced into confinement against their will, for the reason that their families could give them no dower, subjected to the unsatisfied longings, suspicions, bickerings, petty jealousies, envies, and hatreds, so notorious in convent-life, mental disease was not unlikely to be developed at any moment. Hysterical excitement in nunneries took shapes sometimes comical, but more generally tragical. Noteworthy is it that the last places where executions for witchcraft took place were mainly in the neighborhood of great nunneries, and the last famous victim—of the hundreds of thousands executed in Germany for this imaginary crime—was Sister Anna Renata Sänger, sub-prioress of a nunnery near Würzburg.†

The same thing was seen among young women exposed to sundry fanatical Protestant preachers: insanity, both temporary and permanent, was thus frequently developed among the Huguenots of France, and has been thus produced in America, from the

* As to the devil's entering into the mouth while eating, see Calmeil, as above, ii, 105 106. As to the dread of Dr. Borde lest the evil spirit, when exorcised, might enter his own body, see Tuke, as above, p. 28. As to the King of Spain, see the noted chapter in Buckle's "History of Civilization in England."

† Among the multitude of authorities on this point, see Kirchhoff, as above, p. 337; and, for a most striking picture of this dark side of convent-life, drawn, indeed, by a devoted Roman Catholic, see Manzoni's "Promessi Sposi." On Anna Renata there is a striking essay by the late Johannes Scherr, in his "Hammerschläge und Historien." On the general subject of hysteria thus developed, see the writings of Carpenter and Tuke; and, as to its natural development in nunneries, see Maudsley, "Responsibility in Mental Disease," p. 9. Especial attention will be paid to this in the next chapter of this series—"Diabolism and Hysteria."

days of the Salem persecution down to the "camp-meetings" of the present time.*

At various times, from the days of St. Agobard of Lyons through the Reformation period, protests had been made by thoughtful men against this system. Medicine had made some advance toward a better view, but the theological torrent had generally overwhelmed all who supported a scientific treatment. At last, toward the end of the sixteenth century, two men made a beginning of a much more serious attack upon this venerable superstition. The revival of learning and the impulse to thought on material matters given during the "age of discovery" undoubtedly produced an atmosphere which made the work of these men possible. In the year 1563, in the midst of demonstrations of demoniacal possession by the most eminent theologians and judges—who sat in their robes and looked wise, while women, shrieking, praying, and blaspheming, were put to the torture—a man arose who dared to protest effectively that some of the persons thus charged might be simply insane, and this man was John Wier, of Cleves.

His protest does not at this day strike us as particularly bold. In his books, "De Prestigiis Dæmonum" and "De Lamiis," he did his best not to offend religious or theological susceptibilities, but he felt obliged to tell certain truths, to call attention to the mingled fraud and delusion of those who claimed to be bewitched, and to point out that it was often not their accusers but the alleged witches themselves who were really ailing, and he urged that these be brought first of all to a physician.

His book was at once attacked by the most eminent theologians. One of the greatest men of genius of his time, John Bodin, also wrote with especial power against it, and by a plentiful use of Scriptural texts gained, to all appearance, a complete victory: superstition seemed fastened upon Europe for a thousand years more. But skepticism was in the air, and, about a quarter of a century after the publication of Wier's book, there were published in France the essays of a man, by no means so noble, but of far greater genius—Michel de Montaigne. The general skepticism which his work promoted among the French people did much to strengthen an atmosphere in which the belief in witchcraft and demoniacal possession must inevitably wither. But this process, though real, was hidden, and the victory still seemed on the theological side.

The development of the new truth and its struggle against the old error still went on. In Holland, Balthazar Bekker wrote his book against the worst forms of the superstition, and attempted to help the scientific side by a text from the Second Epistle of St.

* This branch of the subject will be discussed more at length in a future chapter.

Peter, showing that the devils had been confined by the Almighty, and therefore could not be doing on earth the work which was imputed to them. But Bekker's Protestant brethren drove him from his pulpit, and he narrowly escaped with his life.

The last struggles of a great superstition are very frequently the worst. So it proved in this case. In the first half of the seventeenth century the cruelties arising from the old doctrine were more numerous and severe than ever before. In Spain, Sweden, Italy, and, above all, in Germany, we see constant efforts to suppress the evolution of the new truth.

But, in the midst of all this reactionary rage, glimpses of right reason began to appear. It is significant that at this very time, when the old superstition was apparently everywhere triumphant, the declaration by Poulet that he and his brother and his cousin had, by smearing themselves with ointment, changed themselves into wolves and devoured children, brought no severe punishment upon them. The judges sent him to a mad-house. More and more, in spite of frantic efforts from the pulpit to save the superstition, great writers and jurists, especially in France, began to have glimpses of the truth and courage to uphold it. Malebranche spoke against the superstition; Séguier led the French courts to annul several decrees condemning sorcerers; the great chancellor, D'Aguesseau, declared to the Parliament of Paris that, if they wished to stop sorcery, they must stop talking about it—that sorcerers are more to be pitied than blamed.*

But just at this time, as the eighteenth century was approaching, the theological current was strengthened by a great ecclesiastic—the greatest theologian that France has produced, whose influence upon religion and upon the mind of Louis XIV was enormous—Bossuet, Bishop of Meaux. There had been reason to expect that Bossuet would at least do something to mitigate the superstition; for his writings show that in much, which before his time had been ascribed to diabolic possession, he saw simple lunacy. Unfortunately, the same adherence to the literal interpretation of Scripture which led him to oppose every other scientific truth developed in his time led him also to attack this: he delivered and published two great sermons which, while showing some progress in the form of his belief, showed none the less that the fundamental idea of diabolic possession was still to be tenaciously held. What this idea was may be seen in one typical statement: he declared that "a single devil could turn the earth round as easily as we turn a marble." †

* See Esquirol, "Des Maladies mentales," i, 488, 489; ii, 529.

† See the two sermons, "Sur les Démons" (which are virtually but two forms of the same sermon), in Bossuet's works, edition of 1845, iii, 236 *et seq.;* also Dzwiecki, in the "Nineteenth Century," as above. On Bossuet's resistance to other scientific truths, espe-

The theological current, thus re-enforced, seemed to become again irresistible; but it was only so in appearance. In spite of it, French skepticism continued to develop; signs of quiet change among the mass of thinking men were appearing more and more; and in 1672 came one of great significance, for the Parliament of Rouen having doomed fourteen sorcerers to be burned, their execution was delayed for two years, evidently on account of skepticism among officials; and at length the great minister of Louis XIV, Colbert, issued an edict checking such trials, and ordering the convicted to be treated for madness.*

Victory seemed now to incline to the standard of science, and in 1725 no less a personage than St. André, a court physician, dared to publish a work virtually showing "demoniacal possession" to be lunacy.†

The French philosophy, from the time of its early development in the eighteenth century under Montesquieu and Voltaire, naturally strengthened the movement; the results of *post-mortem* examinations of the brains of the "possessed" confirmed it; and in 1768 we see it take form in a declaration by the Parliament of Paris that possessed persons were to be considered as simply diseased.

In England the same warfare went on. John Locke had asserted the truth, but the theological view continued to control public opinion. Most prominent among those who exercised great power against the truth was John Wesley, and the greatness and beauty of his character made his influence in this respect all the more unfortunate. The same servitude to the mere letter of Scripture which led him to declare that "to give up witchcraft is to give up the Bible and to take ground against the fundamental truths of theology," controlled him in regard to insanity. He insisted, on the authority of the Old Testament, that bodily diseases are sometimes caused by devils, and, upon the authority of the New Testament, that the gods of the heathen were demons; he believed that dreams, while in some cases caused by bodily conditions and passions, are shown by Scripture to be also caused by occult powers of evil; he cites a physician to prove that "most lunatics are really demoniacs." In his great sermon on "Evil Angels," he dwells upon this point especially; resists the idea that "possession" may be epilepsy, even though ordinary symptoms of epilepsy be present; protests against "giving up to infidels such proofs of an invisible world as are to be found in diabolic possession," and evidently believes that some who have

cially in astronomy, geology, and political economy, see my previous chapters in "The Warfare of Science."

* See Dagron, p. 8; also Rambaud, as above, ii, 155.

† For St. André, see Lacroix, as above, pp. 189, 190.

been made hysterical by his own preaching are "possessed of Satan." On all this, and much more to the same effect, he insisted with all the power given to him by his deep religious nature, his wonderful familiarity with the Scriptures, his natural acumen, and his eloquence.*

But here, too, science continued its work. The old belief was steadily undermined, an atmosphere favorable to the truth became more and more developed, and the act of Parliament in 1735, which banished the crime of witchcraft from the statute-book, was the beginning of the end.

In Germany we see the beginnings of a similar triumph for science. In Prussia, that sturdy old monarch, Frederick William I, nullified the efforts of the more zealous clergy and orthodox jurists to keep up the old doctrine in his dominions. In Austria, the government set Dr. Antonio Haen at making careful researches into the causes of diabolic possession. He did not think it best, in view of the power of the Church, to dispute the possibility or probability of such cases, but simply decided, after thorough investigation, that, out of the many cases which had been brought to him, there was not one to support the belief in demoniacal influence. An attempt was made to follow up this examination, and much was done by men like Francke and Van Swieten, and especially by the reforming emperor, Joseph II, to rescue men and women who would otherwise have fallen victims to the prevalent superstition. Unfortunately, Joseph had arrayed against himself the whole power of the Church, and most of his good efforts seemed brought to naught. But what the noblest of the old race of German emperors could not do suddenly, the German men of science did gradually. Quietly and thoroughly, by proofs that could not be gainsaid, they recovered the old scientific fact established in pagan Greece and Rome, that madness is simply physical disease. But they now established it on a basis that can never again be shaken; for, in *post-mortem* examinations of large numbers of "possessed" persons, they found evidence of brain-disease. Typical is a case at Hamburg in 1729. An afflicted woman showed in a high degree all the recognized characteristics of diabolic possession. Exorcisms, preachings, and sanctified remedies of every sort in vogue were tried in vain. Milder medical means were then tried, and she so far recovered that she was allowed to take the communion before she died. The autopsy, held in the presence of fifteen physicians and a public notary, showed it to be simply a

* For John Locke, see King's "Life of Locke," ii, 173, 174. For Wesley, out of his almost innumerable writings bearing upon the subject, I may select the sermon on "Evil Angels," and his "Letter to Dr. Middleton"; and in his collected works there are many striking statements and arguments, especially in vols. iii, vi, and ix. See also Tyerman's "Life of Wesley," ii, pp. 260 *et seq.*

case of chronic meningitis. The work of German men of science in this field is noble indeed. A great succession, from Wier to Virchow, have erected a barrier against which all the efforts of reactionists beat in vain.*

In America, the belief in diabolic influence had, in the early colonial period, full control. The Mathers supported it fully, and the Salem witchcraft horrors were among its results; but the discussion of that folly by Calef struck it a severe blow, and a better influence spread rapidly throughout the colonies.

By the middle of the eighteenth century the old belief in diabolic possession had practically disappeared from all enlightened countries. In Protestant Germany, where it had raged most severely, it was, as a rule, cast out of the church formulas, catechisms, and hymns, and became more and more a subject for jocose allusion.† From force of habit, and for the sake of consistency, some of the more conservative theological authorities continued to repeat the old arguments, and there were many who insisted upon the belief as absolutely necessary to ordinary orthodoxy; but it is evident that it had become a mere conventionality, that men only believed that they believed it, and now a reform seemed possible in the treatment of the insane.

But, although the old superstition had been discarded, the inevitable conservatism in theology and medicine caused many old abuses to be continued for years after the theological basis for them had really disappeared. There still lingered also a feeling of indifference toward madmen, engendered by the early feeling of hostility toward them, which sufficed to prevent for many years any practical reforms.

What that old feeling had been, even under the most favorable circumstances, and among the best of men, we have seen in the fact that Sir Thomas More ordered acknowledged lunatics to be publicly flogged; and it will be remembered that Shakespeare makes one of his characters refer to madmen as deserving "a dark house and a whip." And what the old treatment was and continued to be we know but too well. Taking Protestant England as an example—and it was probably the most humane—we have a chain of testimony. Toward the end of the sixteenth century, Bethlehem Hospital was reported too loathsome for any man to enter; in the seventeenth century, John Evelyn found it no better; in the eighteenth, Hogarth's pictures and contemporary

* See Kirchhoff, pp. 181–187; also Längin, "Religion und Hexenprozess," as above cited.

† Luther's great hymn, "Ein' feste Burg," remained, of course, a prominent exception to the rule; but a popular proverb came to express the general feeling: "*Auf Teufel reimt sich Zweifel.*" See Längin, as above, pp. 545, 546.

reports show it to be essentially what it had been in those previous centuries.*

The first humane impulse of any considerable importance in this field seems to have been aroused in America. In the year 1751 certain members of the "Society of Friends" founded a small hospital for the insane on better principles in Pennsylvania. To use the language of its founders, it was intended "as a good work, acceptable to God." Twenty years later Virginia established a similar asylum, and gradually others appeared in other colonies.

But it was in France that mercy was to be put upon a scientific basis, and was to lead to practical results which were to convert the world to humanity. In this case, as in so many others, from France was spread and popularized not only the skepticism which destroyed the theological theory, but also the devotion which built up the new scientific theory and endowed the world with a new treasure of civilization.

In 1756 some physicians of the great hospital at Paris known as the Hôtel-Dieu protested that the cruelties prevailing in the treatment of the insane were aggravating the disease; and some protests followed from other quarters. Little effect was produced at first; but, just before the French Revolution, Tenon, La Rochefoucauld-Liancourt, and others took up the subject, and in 1791 a commission was appointed to undertake a reform.

By great good fortune, the man selected to lead in the movement was one who had already thrown his heart into it—Jean Baptiste Pinel. In 1792 Pinel was made physician at Bicêtre, one of the most extensive lunatic asylums in France; and to the work there imposed upon him he gave all his powers. Little was heard of him at first. The most terrible scenes of the French Revolution

* On Sir Thomas More and the condition of Bedlam, see Tuke, "History of the Insane in the British Isles," pp. 63–73. One of the passages of Shakespeare is in "As you Like It," Act iii, scene 2. As to the survival of indifference to the sufferings of the insane so long after the belief which caused it had generally disappeared, see some excellent remarks in Maudsley's "Responsibility in Mental Disease," London, 1885, pp. 10–12.

The older English practice is thus quaintly described by Richard Carew (in his "Survey of Cornwall," London, 1602, 1769): "In our forefathers' daies, when devotion as much exceeded knowledge, as knowledge now commeth short of devotion, there were many bowssening places, for curing of mad men, and amongst the rest, one at Alternunne in this Hundred, called S. Nunnespoole, which Saints Altar (it may be) . . . gave name to the church. . . . The watter running from S. Nunnes well, fell into a square and close walled plot, which might bee filled at what depth they listed. Vpon this wall was the franticke person set to stand, his backe towards the poole, and from thence with a sudden blow in the brest, tumbled headlong into the pond; where a strong fellowe, provided for the nonce, tooke him, and tossed him vp and downe, alongst and athwart the water, vntill the patient, by forgoing his strength, had somewhat forgot his fury. Then was hee conveyed to the Church, and certain Masses sung over him; vpon which handling, if his right wits returned, S. Nunne had the thanks; but if there appeared small amendment, he was bowssened againe, and againe, while there remayned in him any hope of life, for recouery."

were drawing nigh; but he labored on, modestly and devotedly, apparently without a thought of the great political storm raging about him.

His first step was to throw overboard the whole theological doctrine of "possession," and to discard utterly the idea that insanity is the result of any subtle spiritual influence. He simply put in practice the theory that lunacy is the result of bodily disease.

It is a curious matter for reflection that, but for this sway of the destructive philosophy of the eighteenth century, and of the Terrorists during the French Revolution, Pinel's blessed work would in all probability have been thwarted, and he himself excommunicated for heresy and driven from his position. Doubtless the same efforts would have been put forth against him which the Church, a little earlier, had put forth against inoculation as a remedy for small-pox; but, just at that time, the great churchmen had other things to think of besides crushing this particular heretic: they were too much occupied in keeping their own heads from the guillotine to give attention to what was passing in the head of Pinel. He was allowed to work in peace, and in a short time the reign of diabolism at Bicêtre was ended. What the exorcisms and fetiches and prayers and processions, and drinking of holy water, and ringing of bells, had been unable to accomplish during eighteen hundred years, he achieved in a few months. His method was simple: For the brutality and cruelty which had prevailed up to that time, he substituted kindness and gentleness. The possessed were taken out of their dungeons, given sunny rooms for habitation, and allowed the liberty of pleasant ground for exercise. Chains were thrown aside. At the same time the mental power of each patient was developed by its fitting exercise, and disease was met with remedies sanctioned by experiment, observation, and reason. Thus was gained one of the greatest, though one of the least known, triumphs of modern science and humanity.

The results obtained by Pinel had an instant effect, not only throughout France but throughout Europe: the news spread from hospital to hospital; at his death, Esquirol took up his work; and, in the place of the old training of judges, torturers, and executioners by theology to carry out its ideas in cruelty, there was now trained a school of physicians to develop science in this field and carry out its decrees in mercy.*

A similar evolution of better science and practice took place in England. In spite of the coldness, and even hostility, of the

* For the services of Tenon and his associates, and also for the work of Pinel, see especially Esquirol, "Des Maladies mentales," Paris, 1838, i, 35; and, for the general subject and the condition of the hospitals at this period, see Dagron, as above.

greater men in the Established Church, and notwithstanding the Scriptural demonstrations of Wesley that the majority of the insane were possessed of devils, the scientific method steadily gathered strength. In 1750 the condition of the insane began to attract especial attention; it was found that mad-houses were swayed by ideas utterly indefensible, and that the practices engendered by these ideas were monstrous. As a rule, the patients were immured in cells, and in many cases were chained to the walls; in others, flogging and starvation played leading parts, and in some cases the patients were killed. Naturally enough, John Howard declared in 1789 that he found in Constantinople a better insane asylum than the great St. Luke's Hospital in London. Well might he do so; for, ever since Caliph Omar had protected and encouraged the scientific investigation of insanity by Paul of Ægina, the Moslem treatment of the insane had been infinitely more merciful than the system universal throughout Christendom.*

But in 1792—the same year in which Pinel began his great work in France—William Tuke began a similar work in England. There seems to have been no connection between these two great reformers; each seems to have arrived at his results independently of the other, but the results arrived at were the same. So, too, in the main, were their methods; and in the little house of William Tuke, at York, began a better era for England.

The name which this little asylum received is a monument, both of the old reign of cruelty and of the new reign of humanity. Every old name for such an asylum had been made odious and repulsive by ages of misery. In a happy moment of inspiration Tuke's gentle Quaker wife suggested a new name; and, in accordance with this suggestion, the place became known as a "Retreat."

From the great body of influential classes in church and state Tuke received little aid. The influence of the theological spirit was shown when, in that same year, Dr. Pangster published his "Observations on Mental Disorders," and, after displaying much ignorance as to the causes and nature of insanity, summed up by saying piously, "Here our researches must stop, and we must declare that 'wonderful are the works of the Lord, and his ways past finding out.'" Such seemed to be the view of the Church at large; though the new "Retreat" was at one of the two great ecclesiastical centers of England, we hear of no aid or encouragement from the Archbishop of York or from his clergy. Nor was this the worst: the indirect influence of the theological habit of thought and ecclesiastical prestige was displayed in the "Edinburgh Review." That great organ of opinion, not content with merely attacking Tuke, poured contempt upon his work as well as

* See D. H. Tuke, as above, p. 110; also Trélat, as already cited.

on that of Pinel. A few of Tuke's brother and sister Quakers seem to have been his only reliance; and, in a letter regarding his efforts at that time, he says, "All men seem to desert me." *

In this atmosphere of English conservative opposition or indifference the work could not grow rapidly. As late as 1815 a member of Parliament stigmatized the insane asylums of England as the shame of the nation; and even as late as 1827, and in a few cases as late as 1850, there were revivals of the old absurdity and brutality. Down to a late period, in the hospitals of St. Luke and Bedlam, long rows of the insane were chained to the walls of the corridor. But Gardner at Lincoln, Donnelly at Hanwell, and a new school of practitioners in mental disease, took up the work of Tuke, and the victory in England was gained in practice as it had been previously gained in theory.

There need be no controversy regarding the comparative merits of these two benefactors of our race, Pinel and Tuke. They clearly did their thinking and their work independently of each other, and thereby each strengthened the other and benefited mankind. All that remains to be said is, that while France has paid high honors to Pinel, as to one who did much to free the world from one of its most cruel superstitions and to bring in a reign of humanity over a wide empire, England has as yet made no fitting commemoration of her great benefactor in this field. York Minster holds many tombs of men, of whom some were blessings to their fellow-beings, while some were parasites upon the body politic; yet, to this hour, that great temple has received no consecration by a monument to the man who did more to alleviate human misery than any other who has ever entered it.

But the place of these two men in history is secure. They stand with Grotius, Thomasius, and Beccaria—the men who, in modern times, have done most to prevent unmerited sorrow. They were not, indeed, called to suffer like their great compeers; they were not obliged to see their writings—among the most blessed gifts of God to man—condemned, as were those of Grotius and Beccaria by the Catholic Church, and those of Thomasius by a large section of the Protestant Church; they were not obliged to flee for their lives, as were Grotius and Thomasius; but their effort is none the less worthy. The French Revolution, indeed, saved Pinel, and the decay of English ecclesiasticism gave Tuke his opportunity. But their triumphs are none the less among the glories of our race; for they were the first acknowledged victors in a struggle of science for humanity which had lasted nearly two thousand years.

* See D. H. Tuke, as above, pp. 116–142, and 512; also the "Edinburgh Review" for April, 1803.

THE CHEMISTRY OF TO-DAY.

By IRA REMSEN,
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SOME years ago, in the course of a conversation with an eminent mathematician, I asked in all seriousness whether he could give me a definition of mathematics that would convey to my mind even a faint idea of the object in view in mathematical investigation. He replied, "It is impossible to give such a definition—as impossible as it is in the case of chemistry." "But," said I, "I think I can give a definition of chemistry which would have some value"; and then, with little time to think, I suggested a definition, which elicited this remark: "I could certainly give an equally bald definition of mathematics." I have frequently thought of this subject since, and have wondered whether it is possible to convey to the minds of those who are not chemists a clear idea in regard to the work chemists are doing. The difficulties are great—as great, I suppose, as in the case of mathematics; for chemists are no longer engaged in the study of familiar phenomena, but are dealing with matters which lie far beyond the limits of ordinary observation. Still, I have thought it worth while to make the attempt, and it has seemed to me that I might accomplish my object best by calling attention to a few of the most important discoveries which have recently been made in the field of chemistry, and making such comments upon them as may serve to indicate what relations exist between these discoveries and the science as a whole.

Chemistry may be defined as that branch of science which has to deal with the changes in composition which the various forms of matter undergo. Not only has it to deal with these forms of matter, but also with the changes—that is, the acts involved in passing from one form to another. However bald this definition may appear to those who do not understand the subject, it is full of suggestion to the chemist. A chemist is sometimes spoken of as "one whose business it is to tell what things are made of." I accept this statement as expressing half the truth, but I attach to the words a much deeper meaning than they are intended to convey. To illustrate what I mean by this, let me take an example or two. Suppose a chemist is given a piece of marble. On examining it he finds without much difficulty that it is made of the forms of matter called carbon, oxygen, and calcium. He can also tell without much difficulty in what proportions these substances are present in the marble. He may thus tell what marble is made of. But is that all? May we not ask further what are the substances carbon, oxygen, and calcium made of? It is true we call them elements or simple substances, meaning by that substances which can not be converted into anything simpler. No matter what influences the so-called elements are subjected to, they can not at present be decomposed. When, therefore, a chemist, after examining any complex substance, is able to say what simple substances are in it, he tells what it is made of. But, I repeat, is his statement final? Is there nothing more to learn? Plainly the great questions still remain to be answered: What is an element? Are the forms of matter which we call elements absolutely independent of each other, or are they not in turn composed of still subtler forms of matter which we may hope to discover in the future?

While it is impossible to answer these questions at present, some discoveries have been made within the past few years which have a direct bearing upon them. It has been shown by a Russian chemist, Mendelejeff, and at the same time by a German, Lothar Meyer, that the elements are related in a very remarkable way, so closely that it is possible to arrange them all in one table, in which they form parts of a general system. The law governing the variations in properties of the elements is known as the *periodic law*. The limits of this article will not permit any detailed explanation of this remarkable law. The main point that I wish to emphasize is, that these so-called elements are shown to be related to one another, and it seems impossible, in the light of these facts, to believe that they are distinct forms of matter. It seems much more probable that they are in turn composed of subtler elements, and it has been pointed out that all the substances which we now call elements, of which there are about seventy, can be conceived to be made of two fundamental elements combined in different proportions. There does not, however, appear to be any immediate prospect of discovering these fundamental substances, though we can not, of course, tell what a day may bring forth. While the prospect in this direction is not promising, it appears clear that there are other elements of the same order as those now known yet to be discovered. When Mendelejeff first arranged the known elements in his table, he found that the table was not complete, and it became necessary to leave certain places vacant in order to secure a perfectly systematic arrangement. It was as if an incomplete skeleton of some great animal were found. On putting the parts together, the finder would discover that something is wanting to complete the whole, but nevertheless he would recognize the relations between the parts before him. He would also be able to tell what the general properties of the missing parts must be. So here, the discoverer of the periodic law recognized that the system was incomplete. He pointed out the gaps, and prophesied the discovery of elements then unknown which would fill these gaps. Not only this, but he boldly ventured to describe some of these unknown elements in detail. At first no one was inclined to give serious consideration to the predictions; certainly no one dreamed that they would soon prove to be among the most brilliant predictions ever recorded in the annals of science. Within a few years all three of the elements predicted by Mendelejeff were discovered—the last one about two years ago. The first one was discovered in France, and was hence called gallium; the second, discovered in Norway, is known as scandium; and the third, recently discovered in Germany, is the baby element germanium. The descriptions given by Mendelejeff, eighteen years ago, are found to agree marvelously well with the facts. These discoveries have directed the attention of all chemists to the periodic law, and have lent a new interest to the discovery of new elements. There are undoubtedly others still undiscovered. Let us hope that the next one may come to light in the New World, and that we may thus have our own particular element, as France and Norway and Germany have theirs.

It is obvious from what I have already said that, to tell what things are made of, is not so simple a matter as it might at first appear. The best answer we can give, in any case, is lamentably incomplete. But there is another side to the subject, one of fascinating interest. Let me endeavor to illustrate this by means of another example. It has long been known that there are two substances, called respectively glucose and levulose, which are made of the same elements, viz., carbon, hydrogen, and oxygen, in exactly the same proportion by weight. Notwithstanding the fact that these two substances have exactly the same composition, they have markedly different properties. Chemistry abounds in similar examples. To account for these facts, chemists suppose that the parts of which the two substances are made up are arranged differently. An immense amount of work has been done during the past half-century with the object of reaching conclusions concerning what is called the *constitution of chemical compounds*, and the results reached in this field have been brilliant in the highest degree. By methods of the most refined character the chemist of to-day is enabled to enter into the innermost recesses of compounds, and trace out the connections which exist between the constituent parts. Many of the most complex compounds found in nature have thus been studied, their constitution determined, and methods have in many cases been devised by which the substances found in nature can be built up in the chemical laboratory without the intervention of the life process. Among recent achievements in this direction I may mention indigo. This is remarkably complex, and for a long time it had baffled all efforts to determine its constitution; but, finally, that prince of experimenters, Baeyer, of Munich, succeeded, and indigo is to-day manufactured from inert matter; and, though this manufactured article can not yet successfully compete with that obtained from the plant, it is, in my opinion, simply a question of time when the occupation of the plant will be gone.

The subject of the constitution or structure of chemical compounds at present receives more attention from working chemists than any other, and this has been the case ever since chemistry came to be a science. Great progress has been made, particularly within the past twenty or thirty years. In this field, as in that of the elements, to which I have already referred, wonderful predictions have been made and verified. Let me here quote a passage from an address by that eminent physiologist and philosopher Emil Du Bois-Reymond. He says: "I know of no more astonishing production of the human mind than structural chemistry. To develop, from that which appears to the five senses as quality and transformation of matter, such a doctrine as that of the relations between the hydrocarbons, could scarcely have been easier than to develop the mechanics of the planetary system from the motion of luminous points; and Strecker's prediction of the synthesis of creatine, which was afterward verified by Volhard, although in a less exalted sphere, was in fact no smaller achievement than the discovery of Neptune."

Of late, attempts have been made to go still further into the subject of structure, and to get some clew as to what we may call the actual shape of the minutest particles of which all forms of matter are believed to be made up. According to the prevailing theory, every kind of matter is made up of certain minute particles called molecules, and these molecules are conceived to be made up of still smaller particles called atoms. This theory is not merely a wild suggestion of dreamers, but it is forced upon us after a profound study of an immense number of facts. It is found that the facts can be explained only on this assumption. In chemical compounds it is believed that the atoms of elements are united with one another to form the molecules, and that the compounds are made up of these molecules, which are moving around freely in the case of a gas, less so in a liquid, and held together in solids. Now, the problem of the chemist is to determine how the atoms are arranged in the molecule—or to determine what connections exist between the atoms, without reference to the actual arrangement in space. When we consider that the atoms and molecules are almost infinitely small—so small, indeed, that we are told that the smallest particle of matter visible with the help of a good microscope must contain from sixty to one hundred millions of molecules—it does seem in the highest degree presumptuous to make any statement in regard to the way in which the atoms are connected in the molecules. Yet this is just what the chemist of to-day does, and the results accomplished by working in the way referred to fully justify him. Let no one to whom the facts are unknown accuse him of indulging in useless speculation. Chemical hypotheses are for the use of chemists; and so long as they are helpful, so long as they lead to a clearer and clearer recognition of the great truths of our subject, so long as they lead us on to work, and the science grows in consequence, it is not pertinent to remark that there may possibly be a flaw somewhere. If there are flaws in chemical hypotheses, they will be recognized by chemists themselves sooner than by others. Let no one think that science has nothing to do with the realm beyond the senses. Without the aid of the imagination there could be no science. However important they are, facts alone could not constitute a science. It is necessary that the relations between these facts should be discerned, and this can not be done except by the aid of the imagination. There have been few bolder flights than those which pertain to matters of science. The greatest genius is he who sees furthest beyond the facts, and with the aid of his imagination is able to bring together into a harmonious whole those facts which seem least connected. But, it must be remembered, it is the imagination of the thoroughly trained mind, kept in subjection by profound knowledge, that leads to great results.

I have said that of late attempts have been made to learn something of the shape of molecules. Within a few months a remarkable paper, written by Prof. Wislicenus, of the University of Leipsic, has appeared, in which the actual arrangement of atoms in the molecules is seriously and brilliantly discussed. I can not even touch upon the contents of that paper. Suffice it to say that chemists generally are profoundly interested in the arguments of Wislicenus, and the subject is now under active discussion. To me it appears that the views put forward are well worthy of most serious consideration. What the outcome will be, none can predict; but, at all events, the fact is significant that chemistry has reached a stage when such a subject can be discussed.

Another subject which is coming to the front in chemistry is that which I had in mind at the beginning of this article when I said, "I accept this statement as expressing half the truth." It is unquestionably the chemist's business to tell what things are made of, but the other half of the truth is this: it is also his business to study the chemical act itself. In any given case he must not be satisfied when he has learned that when two substances, A and B, are brought together, they combine to form the new substance, A B. He must study that act of combination, and learn all he can about it. As these acts in most cases take place almost instantaneously, this kind of study is exceedingly difficult. Nevertheless, some progress has been made within the last few years, and the number of chemists who are taking up work in this field is rapidly increasing. They are investigating such matters as the speed of chemical action, the influence of mass upon chemical reactions, and the relations between the phenomena of heat and electricity and chemical action. The best results have come from Russia, Sweden, and France. This branch is frequently referred to as physical chemistry. A number of books treating the subject have recently appeared, and a journal devoted exclusively to it has been started within the past year.

Now that I have begun to tell of the achievements of chemistry, I would fain continue; but, rather than run the risk of wearying my readers, I will turn at once to another subject, which I would gladly discuss at some length, but which I shall have to dismiss in a few words. I think I hear the remark: "This is all very well, but I thought chemistry was a practical science. What is the good of all these refined investigations on the nature of the elements and the constitution of chemical compounds? Can not the chemist find something more practical to work on?" These questions are constantly asked, and it is clear to me that they need answers. I take it that by the word practical is meant something which has a direct bearing upon our every-day lives. A practical investigation is one that leads to the establishment of some new industry, or it is one which leads to the discovery of some substance which can be used by man. My practical brother, then, has no sympathy with the kind of work I have been speaking of, but demands that the work should be of such character as to lead directly to results which can be utilized at once by mankind. It can not be denied that there is much that is reasonable in this demand. It is right that the results of scientific work should be made available, and that they should be utilized to the fullest extent for the improvement of man's condition. It is impossible to overestimate what we owe to chemistry, and we may confidently expect even greater gifts in the future than those which we have already received. Every year some new application of chemical discoveries is made. To whom do we owe the possibility of these applications? My answer is distinctly: We owe it to those chemists who are engaged in investigations in the field of pure science. Everything that tends to the perfection of the science of chemistry is of value in connection with the applications of chemical truths. The most refined investigation on the most abstruse chemical subject may furnish a link in a chain of argument—may be the one thing needed to lead to a most important generalization. The interests of the chemical industries and of the pure science of chemistry are identical. I do not ask that my assertion be accepted as final evidence on this point. I ask attention to the important fact that the seat of the great new chemical industries of the world is that country in which the greatest attention is paid to pure chemistry. As the result of much experience in Germany, it has been found that those chemists who are best versed in the pure science are the best fitted to go into the great factories and conduct the chemical operations. Even in the technical schools in Germany the subject of chemistry is taught just as it is in the universities, in such a way as to give the student as much as possible of the pure science. If my practical brother could make a tour of the great laboratories of the world, whether in universities or in polytechnic schools, he would find that the subjects under investigation in ninety-nine out of a hundred of them are such as he would regard as in a high degree unpractical; and yet I say the experience of the world has shown that, where the most of this unpractical work is done, there the most practical results are reached. The testimony of chemists is unanimous on this point. We are therefore led to the conclusion that the most unpractical work is the most practical—a conclusion which I am sure will stand the test of the closest examination.

But I do not think that this last argument is needed to justify the abstract chemical work of which I have been speaking. Man can be improved in other ways than by ministering to his daily bodily needs. He has higher needs, and some of these are ministered to by enlarging the world of ideas. Every discovery is an addition to the world's stock of knowledge, and we are all gainers by these discoveries. The gain is not as tangible as the material ones, but it is none the less valuable. Is not the world better off for its books, its works of art? Take them away. Imagine the result! So it is with the results of scientific work. By the aid of this work we are advancing toward clearer conceptions of the universe and our position in it. Stop the work, and intellectual death must necessarily follow. The work must go on entirely independently of the question whether the results can be utilized at once or not. We need more light! Let us work for this.

Prof. Lodge, assuming that light is an electrical disturbance, reasons that all our present systems of making light artificially are wasteful and defective. We want only a particular range of oscillations, but to obtain them we have to produce all the inferior ones leading up to them. The force thus expended is thrown away. With his energy properly directed, a boy turning a handle could produce as much real light as we get with all our present expenditure. The waste is worse when we get light by combustion than with the electric lights, for then the air as well as the fuel is consumed, and the low heat-rays that are thrown out cause inconvenience as well as being wasteful. The light of glow-worms and of phosphorescence is produced without waste. We must learn to obtain light with equal economy.

GLASS-MAKING.

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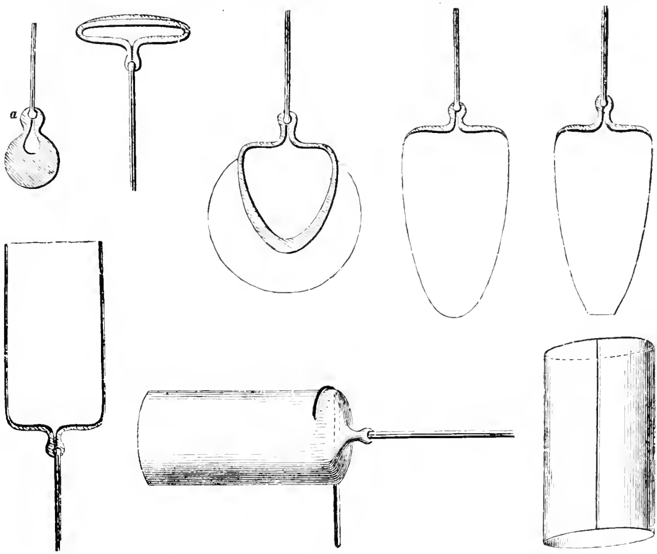
I.—A PANE OF GLASS.

"O CARLYLE!" exclaimed Emerson, in his diary, at the time "Sartor Resartus" was being republished in America, "the merit of glass is not to be seen, but to be seen through; but every crystal and lamina of the Carlyle glass shows."

With admirable precision this defines the proper function of a pane of glass. Decorative art, in casting about for new fields of conquest, has too frequently induced a contrary feeling; but, after all, a window-pane at its best is something to be seen through and not to be seen. It is our means of looking out upon the world and letting the sun look in upon us. The more perfectly, then, it fulfills its function, the less evidence will it bear of its evolution from such dull things as sand and lime and soda-cake. Our window-pane is transparent in all things save its own history. It gives no hint of what it is made of, or how it is made. It is, indeed, easier to look through it than it is to look into it. If one look in the right direction, however—and in America this means toward Pittsburgh—he will see, in the cluster of glass-factories which have gravitated toward the natural gas of that neighborhood, a side of industrial activity possessing much interest. The brilliant pane of glass itself tells no stories, but the white-hot furnaces and pots of molten metal, the active, hurried figures, and the movements of rare dexterity that one sees at these places, are far more communicative.

They can well afford to publish their achievements, for about few of its material products can the nineteenth century boast with so much show of justice as about its window-glass. It is true that past ages have produced quite as remarkable technical results in other departments of industry, but in this one product, at least, the present decade appears to be unique. Not even China and Egypt, which have a standing claim of priority on all the arts and sciences, dispute with the modern glass-maker. His triumphs are without rival.

Contrary legends are afloat, but they can be chased into no fact. There is, for instance, a story current about the Queen of Sheba and the wise King Solomon that quite puts into the shade even the deceitfulness of riches. It is related by some gossipy chronicler that, at the time of the famous visit, the royal audience was so arranged that the queen and her suite in approaching were obliged to pass over a floor of glass under which were flowing water and fishes swimming. For the legend has it that the wisest of men was decidedly curious. The Paul Prys of Jerusalem declared that the queenly visitor labored under the disadvantage of a deformed foot. The ingenuity of the monarch, it is said, suggested the device of the simulated stream, thinking that the lady's anxiety for her draperies would disclose to the court of Israel whether rumor had rightly reported her. But this performance is probably attributable to the imagination of one somewhat later than Solomon. It hardly sounds like the author of the "Proverbs," nor have we any record that the lady ever repaid



SUCCESSIVE STAGES IN THE MANUFACTURE OF SHEET GLASS.

him for his discourtesy—a bit of negative evidence that is almost conclusive. But at that time so inhospitable a scheme, even if seriously entertained, could scarcely have been carried out. The hundred and twenty talents of gold and the very great store of spices and precious stones, which to the queen's presence in Jerusalem added their tribute of admiration for wisdom, could not have purchased in any of the marts of the ancient world a plate of glass sufficiently large and sufficiently clear to have made such a deception possible.

The glass-blowers of the olden times undoubtedly produced some fine results in color, which can scarcely be equaled in the present. They had already attained, in the fabrication of rare and curious forms, a considerable fame before the days of the Roman supremacy; but the magnificent sheet of glass through which we of a morning study the signs of the weather, or glance at the too tempting displays in the shop-windows, is a luxury which we must admit to be peculiar to our own times. It might gain for us the title of the "age of glass," had not the age already been devoted successively to the genius of iron, of steel, and of electricity.

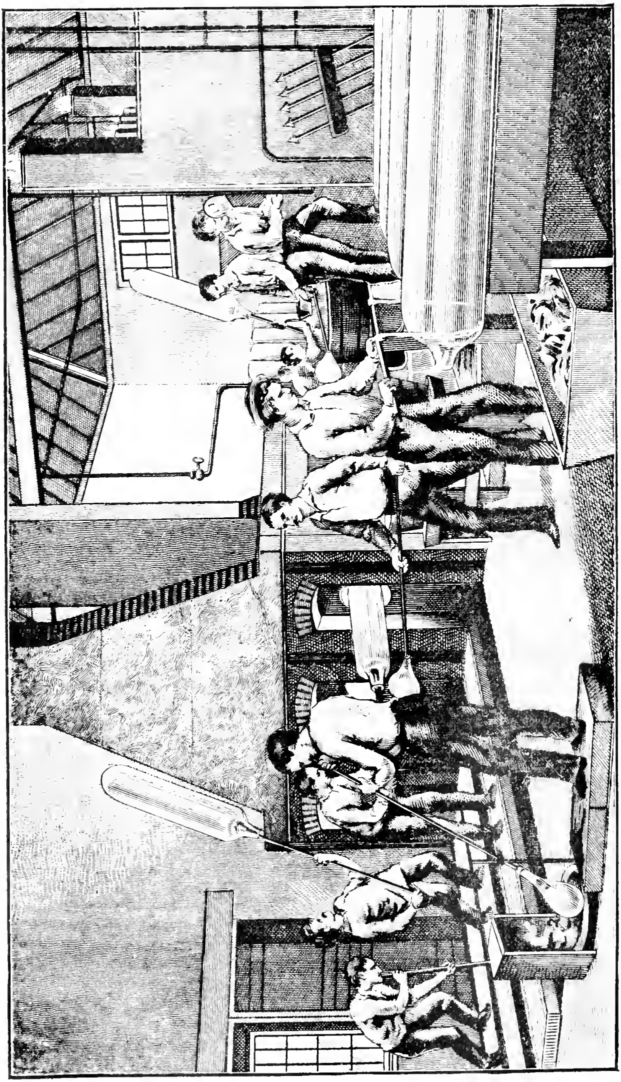
There is also observable a marked difference in the spirit in which the earlier and the later artisans worked. While glass was still a product of some rarity, its manufacture naturally occupied a place among the fine arts rather than among the more common industries. The early glass-makers, in consequence, busied themselves more with the production of the costly and the beautiful than in any attempt to bring glass in its manifold applications within the reach of the poor. Later workers, on the other hand, have shown the influence of democratic institutions. They have found their greatest pleasure, as well as their greatest profit, in the production of wares of such utility and cheapness that their market includes even the very poorest. As a result of this enlarged production, the history of glass shows a marked increase in quality and a marked decrease in price. The interest aroused by this progress is not only technical and commercial, but, in the case of window-glass, in a still wider sense social and economic. In filling the windows of our houses with transparency, the glass-maker has been a public benefactor. His benefaction is the greater, since the material he supplies is now at the disposal of even those of limited means. We hardly appreciate the full significance of cheap window-glass. It lengthens the day to the dimensions assigned by Nature, and permits one to enjoy the sunshine of out-door life without exposure to the inclemencies of the weather. These are substantial contributions to the public health and well-being. At no previous time, we believe, could the dwellers in northern climes introduce into their homes so many square feet of sunlight for so little money.

It is the purpose of the present article to offer a brief glimpse of some of the processes involved in the metamorphosis of the crude materials into a serviceable pane of glass. As the operations are actually carried out in the arts, the attention of the onlooker is constantly distracted by the flame and glare of the furnaces, the passing and repassing of red-hot glass, the clouds of steam, and puffs of dust and smoke. He comes away from the factory with an impression limited to the more spectacular features of the process. Of necessity he is quite oblivious of a hundred details of which it is very necessary that the glass-maker should be distinctly sensible. In making this visit by deputy, it is proposed that little more shall be seen than falls to the lot of the flesh-and-blood visitor. It is, perhaps, wiser that the uncertain light and the steam and smoke shall be permitted to cover with their convenient mantle those technical details that would fail to attract general interest. In such matters it is uncomfortable to have your guide too knowing if he insists on sharing all his knowledge with you.

To define glass physically would be a superfluous task. Every one is informed of its hardness and solidity. A series of annoying accidents has demonstrated beyond doubt its exceeding brittleness. The ragged-edged splinters that result from such occasions suggest that the solid is amorphous, or without regular crystalline form.

To define the material chemically may be less unnecessary. It is a mixture of different silicates—that is to say, of mixtures of silicic acid with the bases soda, potash, lime, magnesia, alumina, iron, and lead. Considering that we are to be non-technical, this is rather a formidable list, but it must not be thought that any one glass contains all of these ingredients. Every true glass consists of at least two metallic bases united with the silicic acid, and generally, by virtue of the impurities of the crude material, traces of several more. So we have grown into the habit of designating the different kinds of glass by the names of the two predominant bases. Window glass, for instance, is known as a lime-soda glass; table crystal as a lead-potassium glass, and so on through the list. This system of nomenclature is open to the objection that the name of the product and its composition do not correspond in all the glass-producing countries, but these technical discrepancies seem unavoidable. The physical properties of the glass follow very closely its chemical constitution. Many of the silicates employed in glass-making are entirely infusible alone, but, when given suitable associates, are quite manageable. The weight of the glass is also directly dependent upon the metallic bases with which the silica is combined. Crystal is made heavy by the lead present, while window glass, having only light bases in its make-up, has a correspondingly small weight. It is little more than two and a half times as heavy as water. Each chemical change has its physical counterpart.

In spite, however, of the relative cheapness of glassware, we have still a pane of glass for the rich and another for the poor. Both products, the plate and the sheet glass, have essentially the same composition, but they differ very much in the purity of the crude materials used, and in the method of fabrication. Of recent years the improvements in the manufacture of sheet glass have been so marked that it is now frequently introduced into buildings of the better class in place of the more expensive plate. On



The Interior of a Sheet-Glass Factory.

the other hand, the processes of manufacture by which the latter glass is produced have been so far perfected that its use is now permitted to many who would hitherto have thought themselves unable to afford it.

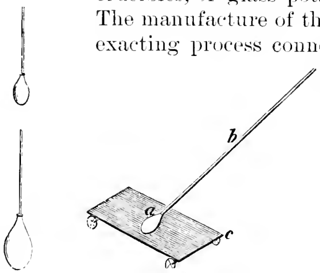
A third form of window glass, the so-called crown glass, must also be mentioned for the sake of completeness, though it has little commercial importance, and less in America than in England. Both sheet and crown glass owe their origin to the blower's breath. Though they are less brilliant than the plate, their methods of fabrication are much more interesting, since they involve a far greater amount of manual dexterity on the part of the artisans. It is, indeed, difficult to know which to admire the more, the chemistry or the physics of the operation; the nicety with which the glass-maker regulates the proportions of his charge so as to produce this beautifully clear substance, or the skill with which he subsequently handles the finished glass and adapts it to our uses.

Sheet glass forms the window-pane of the multitude. The possibility of making it of excellent quality and in large sizes is due almost entirely to the substitution of gaseous for solid fuel. No other among our numerous American industries has been so benefited by the utilization of natural gas. European sheet glass was up to this time unquestionably superior to our own. A larger experience and more approved furnaces made it possible for the foreign manufacturers, and particularly those of France and Belgium, to solve with greater success the knotty problems connected with glass-making. In many places they had already substituted gas for coal, and obtained the happiest results. With the advent of natural gas the position of the American producer was suddenly changed. He had at his command the most desirable of fuels, and one that was at the same time very cheap and almost totally free from sulphur. As a result, he soon equaled and now surpasses his transatlantic rivals.

But the manufacture of window glass is essentially difficult. Even when the troublesome question of fuel has been satisfactorily settled, there remain many other substantial difficulties which must be met and conquered. From the mixing of the crude materials to the annealing of the finished product, the glass-maker must be alert and intelligent. It is a very easy matter simply to make glass. Sand, metallic bases, and heat are the only elements needed. But to make good glass—glass that is clear, transparent, colorless; that simulates the purest water of a mountain-stream—this requires skill and patience. From beginning to end the process is one of painstaking and delicate manipulation.

In the genesis of a pane of glass, the first step is naturally the provision of such stuff as it is made of. While glass is theoretically a definite chemical compound, the proportions in which the ingredients of the "batch" are mixed vary in every establishment. Sand is the basis of the operation. It is the commercial representative of silicic acid. With this are mixed lime and alkali (either carbonate or sulphate of soda, or both) in sufficient quantity to furnish an easily fusible mass that, on solidifying, shall be both clear and transparent. There is very wide range in the choice of materials. The purest grades have the disadvantage of costliness, while the inferior glass has the equal disadvantage of commanding but an indifferent price. Between these two considerations swings the balance of expediency.

When the batch has been made up, it is melted in large clay crucibles, or glass pots, as they are commonly called. The manufacture of the pots is the most tedious and exacting process connected with glass-making. It is one of the few industrial operations in which machinery has not been able to supersede man. A mixture of raw and burned fire-clay is employed. It is necessary that this should be prepared with the greatest care. Once a day for at least four weeks the mass must be turned and worked, in order to get it free from air and give it the proper toughness. For this kneading process no tool has been found equal to the bare foot. There are a warmth and an elasticity about it that better than anything else develop the required plasticity in the clay. Barefooted men, pacing up and down in lead-lined troughs, present a very primitive industrial picture. The impression is not removed when one goes up-stairs and watches the transformation of this much-worked material into crucibles. The hand here occupies the place that the foot does below-stairs. By equally slow stages the crucible is built up. First the bottom is formed, a circular slab about four inches thick and some forty inches in diameter; then the sides are gradually raised, a little addition being made each day, until at the end of about six weeks the work is completed, and a heavy, tub-shaped crucible is the result. Meanwhile the incompleted walls are kept constantly covered with damp cloths to prevent premature hardening. The temperature and humidity of the work-room are also objects of unremitting attention. But, though the crucible has now taken form, and its material been under treatment for more than ten weeks, it is not yet ready for the trial by fire. Several months must pass before it is considered sufficiently dried to withstand even a prelimi-



THE OPERATION OF "MARVERING."

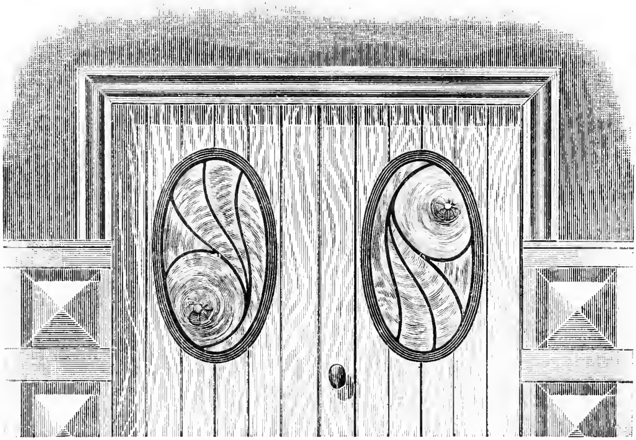
nary heating. When the time comes, this is done very cautiously in a little furnace specially constructed for the purpose. Here the temperature is gradually raised to that of the melting furnace. The transfer from the one to the other is accomplished as rapidly as possible. The interior of the crucible is then glazed with a little molten glass, and the vessel is ready to lend itself to the transformation of the opaque into the transparent. After a variable term of servitude, whose length is totally unpredictable, the crucible finally succumbs to the combined attacks of heat and chemical action, and must be replaced by a fresh one.

When gas is used as the fuel, the melting furnace is a very simple affair. It consists of a plain rectangular floor or hearth, which supports from eight to ten crucibles, two abreast. On each side of the furnace there is a series of round openings giving access to each pot. Arches at the end permit the admission of the fresh crucibles and the removal of the exhausted ones. The chimney is placed in the center, the gas being admitted at each end. The air necessary for combustion is first heated by passing through chambers in the base of the furnace. It will not be necessary to go into any further details of construction, for if one will simply imagine a white-hot apartment, perhaps forty feet long, eight feet wide, and six feet high, with ten crucibles of molten glass standing two abreast on the floor, and half as many openings on each side, he will have a sufficiently vivid picture of the melting furnace of a glass-factory. The batch is introduced into the crucibles in small quantities at a time, and then patiently coaxed into a proper degree of fluidity. When the last portion is added, a decolorizing agent goes with it, for, however pure the crude materials may be, there is always sufficient iron present to give the glass a greenish cast. Arsenic is a favorite bleaching agent. It acts by converting the iron into a higher oxide. In some establishments the peroxide of manganese is used for this purpose, but the least excess gives the glass a pinkish color, and it is also thought to make its transparency less durable.

Style dominates even so apparently an unmodifiable thing as window glass. Some years ago a slight excess of manganese was employed intentionally. It was thought that the mistress of the house—or her daughters—looked the prettier when seen through rose-colored window-panes. This decidedly pink glass may still be seen in not a few of the older houses in our Eastern cities. Its use is occasionally revived by some emergency.

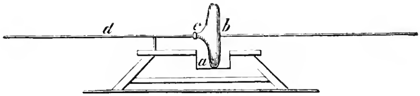
This completes the chemistry of the process; the remaining operations are purely physical.

After the contents of the crucibles have become thoroughly fused, the temperature of the melting furnace is gradually reduced, so that the molten glass shall become less liquid, and thus ready for the process of gathering. The impurities floating on the surface of the "metal" are first removed by skimming, much as the housewife does with her preserves. When the crucible was originally put into the furnace a fire-clay ring was placed in the bottom of it, and now floats on the bath. By removing all the scum from the interior of this ring the gatherer always has a clear surface from which to draw. The blow-pipe which he uses is simply a wrought-iron pipe about five feet long. It is provided at one end with a mouth-piece and wooden handle; the other end is thickened and somewhat flared, after the manner of a trumpet. This is dipped into the molten metal, and when withdrawn brings



Crown Glass in Decorative Work.

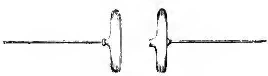
with it a small lump of glass. By a dexterous turn of the pipe this plastic mass is formed into the shape of a symmetrical oval. The dipping process is several times repeated until a considerable mass of glass adheres to the end of the pipe. When window glass of double thickness is to be made, at least four or five gatherings are necessary. It is at the final dip that the gatherer's greatest skill is called into requisition. It is a pleasure to watch him as he seemingly toys with his blow-pipe. But each little movement is done with a purpose. The mass of glass on the end of his pipe is the result of successive gatherings, and must now be brought into a state of perfect homogeneity. To accomplish this, the last glass added is made to completely overlap the whole mass. The ball is then brought almost to a liquid condition, and seems ready to fall from the pipe. In less skillful hands, it would certainly come to grief. By a quick turn of the implement, however, the gatherer throws the fold of glass into a spiral form, and so works it to the end of the mass. This leaves a perfectly clear and semi-plastic ball. The pipe is now withdrawn from the furnace and taken to an open wooden mold, or trough, where the glass is formed into a pear-shaped mass. The mold is kept constantly wet, to prevent its burning. The water, in contact with the red-hot glass, assumes the spheroidal condition, and looks like so many globules of mercury. The gatherer's duty is now at an end, and he returns to the melting furnace to repeat the operations of gathering until the crucibles are emptied of their contents. The blow-pipe and its red-hot burden, meanwhile, have been taken in charge by the blower.



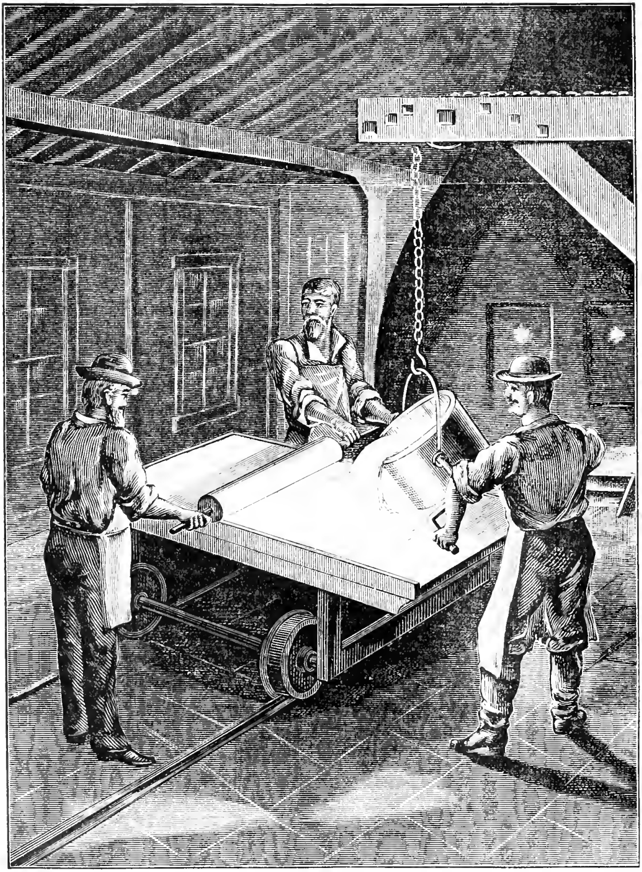
ATTACHING THE "PONTY."

On the continent of Europe the same furnace is generally used for both melting and blowing, but in England and America it has been found more advantageous to employ separate furnaces. They are very similar in construction. The blowing furnaces have, however, somewhat larger side-openings, and the gas, instead of being introduced at the ends, is burned directly under the openings, or blow-holes. The furnace simply provides an intensely hot chamber for controlling the temperature of the glass under manipulation. On each side of the furnace, and directly in front of the blow-holes, there is a wide platform built over a cellar, or pit, perhaps ten feet deep. Long openings in this platform run at right angles to the furnace, and permit the blower, when occasion demands, to swing his pipe and its burden in the pit beneath.

The sheet-glass factories of Pittsburgh are equipped as thoroughly as any in the world. The division of labor is everywhere carried to the extreme. Each man knows how to do a particular thing, and does it. The blower, for instance, into whose hands the red-hot ball of glass has just been consigned, is supposed to know little or nothing about the other operations involved in glass-making. He begins at a certain point, and leaves off at a certain point. The skill with which he effects his part in the many transformations required in the genesis of a pane of glass is, however, the most attractive in a process nowhere devoid of interest.


FORMING THE "NOSE."

His first act is to grasp the pipe, and, with the ball of glass still resting in the wooden mold, blow through the mouth-piece until a large bubble of air is formed in the midst of the mass; then, with alternate blowing and manipulating, he so increases the size of the bubble that the ball of glass assumes a shape not unlike that of the large carboys used in the transportation of



Casting Plate Glass.

acids. He now transfers himself and his work to the platform in front of the furnace. Sometimes blowing, sometimes swinging his pipe in the pit beneath him, and sometimes reheating the glass in the blowing furnace in front of him, the blower gradually extends the dimensions of the bubble of air until the ungainly car-boy, with its disproportionately thick bottom, has been replaced by a beautifully symmetrical figure, the shape of an enormous test-tube. But it occasionally happens that the glass flows a little too freely, and there is danger of the sides of the tube becoming too thin. To avoid this result, the blower throws his tube into the air whenever he finds that the glass is too liquid, and thus permits it to settle back upon itself. As the tube by this time is about five feet long, in addition to the length of the pipe itself, one can readily fancy that this apparently playful toss requires both skill and muscle. It is a fine sight to watch the graceful ease with which these brawny fellows accomplish it.

When the tube has been formed to the satisfaction of the blower—and it requires a surprisingly short time for the whole operation—he allows it to become comparatively cool. He then thrusts the rounded end into the furnace, blows into the mouth-piece of his pipe, and quickly covers the opening with his hand. Presently, a slight report is heard, like a mild explosion. The confined air, expanding with the increasing temperature, has blown a hole in the end of the softened tube. Resting his pipe on a convenient support, and still keeping the glass in the furnace, the blower gradually rotates the tube. Under the influence of centrifugal force, the hole grows larger and larger, until the tube becomes an open cylinder. It is then quickly withdrawn from the furnace and permitted to depend into the pit beneath the platform. When the plastic edge passes to a cherry heat, the cylinder may be taken away without danger of getting out of shape.

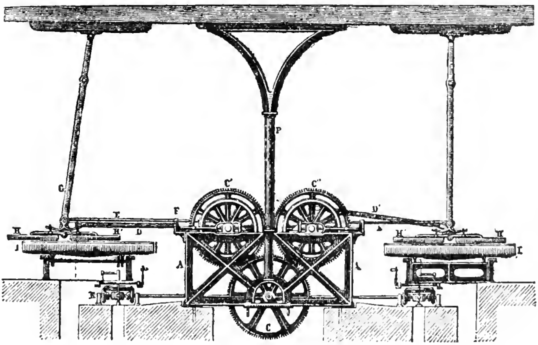
The blower's part is now finished. After a moment's rest, he has another pipe in his hand, and is repeating his heavy labor. His wages are considerably larger than the salary of many a learned professor or divine, but the service for which they are paid is of such a kind that it makes a man grow old very early. The severe muscular exertion, and the high temperature at which it is performed, are not conducive to either health or longevity. There may be exceptions, but as a rule there are few constitutions that can withstand for any length of time the quickly alternating heat and chills to which the glass-blower is daily subject.

The cylinder just laid aside is now cold. As soon as the neck and its attached blow-pipe are separated from it, a red-hot iron is passed along the interior surface from end to end. A piece of cold iron applied to any part of the heated line makes a complete longitudinal crack. We have now before us a perfect cylinder, open at both ends, and cracked from end to end. It has only to be ironed out into a flat sheet to be ready for service as a pane of glass.

The ironing process is carried out in a separate building, in what is known as the laying-in furnace. The ease with which it is accomplished is one of the triumphs of modern glass-making. In this department particularly, the merits of natural gas are each day more apparent. The hearth of the laying-in furnace is circular, and is divided into a number of sectors by fire-clay bridges. It is made movable about a vertical axis. As it rotates, the different sectors of the hearth pass through as many separate compartments of the furnace, the temperature of which may be varied at pleasure. The first compartment, the laying-in oven, is only moderately warm, and permits the glass cylinder to become gradually heated. It is then carried by a partial rotation of the hearth into the next compartment, the laying-out oven, where the heat is sufficient to make the glass plastic. A large, flat stone occupies each hearth-section and forms the ironing-board upon which the cylinders of glass are to be smoothed. In the laying-out oven, the crack in the cylinder is brought uppermost. Under the influence of the heat the glass gradually unfolds, until it lies open on the stone like a sheet of rumpled paper. In the succeeding compartment—the flattening oven—the plastic sheet is made perfectly smooth and flat by means of a moist block of wood on the end of a long iron rod. The cylinder has now disappeared, and in its place there is a pane of red-hot glass. One more turn of the hearth carries the glass into the compartment known as the dumb oven, where it gradually cools. It is then brought, by a final movement of the hearth, to the entrance of the annealing leer. One whole rotation has now been accomplished, and the circuit is complete. Meanwhile other cylinders have been put into the furnace and are in different stages of the flattening process.

The operation of the furnace is continuous, and speedily transforms the cylinder into a smooth sheet. But still it is not ready for use. Were the glass removed to the air immediately, it would be much too brittle for service. It must first go through the process of annealing, or gradual cooling, before it can possess any durability. In the improved "rod leer" the hot glass is received at one end of a long brick chamber, and in thirty or forty minutes it is automatically discharged at the other end, nearly or quite cold. Where gas is used, the glass, just as it comes from the leer, is beautifully clear and brilliant. It could scarcely be more so had it been washed with hot water and dried with linen —the process, we believe, by which madam, our hostess, secures such a glittering display on her table. The sheets are at once cut into proper sizes and stored away in suitable wooden frames. The process of manufacture is completed, and only the service of the glazier is needed to put the pane in place, and so inaugurate its luminous mission.

Strange fancies attend the visitor as he wanders through the silent warehouse. He loses himself amid the possible pictures which these window-panes are destined to confront. Perhaps the old fable of the wind and the sun comes back to him. The cloak that the one in all its fury could not tear off is gladly thrown aside when the other exerts its power. The same with our pane of glass. It is to repel the rougher storms and winds, yielding passage only to the gentler elements. Sunshine and moonlight are to filter through it, and back of it pleasant fireside pictures are to group themselves. But the imagination is not always so obliging; darker possibilities obtrude themselves as well. The shuddering forms of want and wretchedness are also there, and the solitary dreamer is glad to turn away from them all, and pass out of the open door back again into the world of reality.



ROTARY GRINDING MACHINE FOR PLATE GLASS.

The manufacture of crown glass possesses considerable historical interest, but little beyond that. Within the past few years it has been brought into some prominence again from its growing use in decorative windows. It possesses, it is true, a brilliancy much superior to that of sheet glass, but the small size and unequal thickness of the pane obtainable do not permit it to compete successfully with the generous dimensions and remarkable uniformity of the glass now dominant. In mode of fabrication the crown glass proceeds precisely as the sheet up to the time of blowing; at this point the two processes diverge. The ball of semi-plastic glass on the end of the blow-pipe is fashioned into the shape of a cone, as the result of successive rollings on a table of metal or stone, known as the "marver." The process itself goes under the name of "marvering." The apex of the cone forms the so-called "bullion-point." By blowing into the mouth-piece of his pipe, the blower expands the glass into a small globe. This is subsequently enlarged, care being taken that the bullion-point is always kept in line with the pipe. The globe of glass is then flattened into something the shape of an enormous decanter. The bottom is very flat, and has the bullion-point exactly in the center. The pipe and its ungainly burden are now permitted to rest horizontally on two iron supports. In the mean time a second workman has gathered a small lump of glass on the end of his iron rod, or "ponty," and by pressing it against an iron point forms it into the shape of a tiny cup. This is fitted over the bullion-point of the glass, and, as they are both hot, soon becomes firmly attached to it. The glass has now two handles, but one of these, the blow-pipe, is speedily separated from it by means of a sharp blow. The open neck which is thus exposed is known, in the glass-maker's parlance, as the "nose." It gives its name to the furnace where it is subsequently reheated. During this operation the ponty is constantly and rapidly revolved. The nose gradually expands under the combined action of heat and centrifugal force. The opening grows larger and larger until the glass assumes the shape of a typical crown. This appearance, however, remains but an instant. One sees in its place a brilliant circular plate of glass whose shape is only maintained by continuing the rotation of the ponty until the plate, or table, as it is now called, can be placed upon a flat support. The ponty is then detached from the bullion-point by means of shears. The mark that is left is known as the bull's-eye. The tables vary in size from a few inches in diameter up to six feet, but this latter dimension is extreme. After annealing they are cut into panes by means of a diamond. The loss involved in the operation more than counterbalances the admirable brilliancy of the material. At the present time, the circular tables, just as they come from the annealing oven, are being used in decorative windows with the most excellent effect. Frequently the glass is tinted, or else it is left colorless itself, and the bull's-eye is either shaded or opalescent.

The window-pane of the rich is commonly plate glass. Of the three varieties, this is by far the most desirable in everything except, it must be added, the price. Though similar in composition to the sheet and the crown glass, its fabrication is carried out upon a totally different principle. Instead of being, like them, the result of the blower's breath, the plate glass is cast into a flat sheet and then ground and polished, a process of manufacture which at once accounts for its expensiveness. The best practice to be seen anywhere in America, if not in the world, is at Creighton, some twenty miles north of Pittsburgh. It is near the well-known natural-gas district of Tarentum. There are a number of large establishments in this country where plate glass is manufactured, but the Creighton plant enjoys the reputation of possessing the most favorable economic conditions as well as the best equipment.

In the selection of the crude materials great care is taken to secure purity. The melting is carried out in large, open pots, the furnaces differing in their construction from those already described only in their greater size, and in the substitution of iron doors lined with tiles for the customary gathering-holes. When the melting is completed, the door nearest the pot to be emptied is opened, and a two-pronged fork, mounted on wheels, is inserted into the furnace. The prongs fit into depressions in the sides of the melting-pot, and thus secure it in a firm grasp. The pot of molten metal is then removed from the furnace and carried on a low truck to the casting table. At Creighton, the casting house, containing furnaces, tables, and annealing ovens, is 650 by 160 feet, about four times as large as the famous *halle* of Saint-Gobain in France, and nearly double the size of the British casting house at Ravenshead. The capacity of the American works has recently been greatly increased, and several new plants established in different sections of the natural-gas territory. The casting tables, the most important pieces of apparatus in a plate-glass works, are nineteen feet long, fourteen feet wide, and seven inches thick. Each is provided with an iron roller, thirty inches in diameter and fifteen feet long. Strips of iron on each side of the table afford a bearing for the rollers and determine the thickness of the plate of glass to be cast. The rough plate is commonly nine sixteenths of an inch in thickness; after polishing, it is reduced to six or seven sixteenths. The casting tables are mounted on wheels and run on a track that reaches every furnace and annealing oven in the building. The table having been wheeled as near as possible to the melting furnace, the pot of molten glass is lifted by means of a crane, and its contents quickly poured on the table. The heavy iron roller is then passed from end to end, spreading the glass into a layer of uniform thickness. The whole operation of casting scarcely occupies more time than it takes to describe it. Each movement is made with almost nervous rapidity. Few industries offer such fine scenic display as the pouring of the molten glass. One feels like crying *Encore!* it is so very brilliant.

In contact with the cold metal of the table, the glass cools rapidly. As soon as possible, the door of the annealing oven is opened, and the plate of glass introduced. The floor of the oven is on the same level as the casting table, so that the transfer can be conveniently and quickly made. When, after several days, the glass is taken out of the oven, its surface is found to be decidedly rough and uneven. A small quantity is used in this condition for sky-lights and other purposes where strength is required without transparency. It is known in the market as rough plate. The greater part of the glass, however, is ground, smoothed, and polished before it leaves the establishment. The work of the " hall men" ends with the production of the rough plate. Its next guardians bear the name of "grinders." These confer upon the glass the property of transparency. The grinding is accomplished by means of rotary grinding machines, the abrading material being common river-sand, dredged from the Alleghany. Several million bushels are annually required for this purpose. The plates are firmly fixed on rotary platforms by means of plaster of Paris, and rotating disks are so arranged that they cover the entire surface of the plate at each rotation of the platform. Small jets of water keep the grinding-sand constantly wet. But such treatment only removes the rough exterior; the smoothing is accomplished by means of emery, finer and finer grades being used as the process proceeds. The final polish is given by means of rouge (carefully calcined sulphate of iron), which leaves the glass perfectly smooth and ready for use.

Many doubtless remember the time—not so very long distant—when such a thing as American plate glass was totally unknown. It all came from France. But we have discovered—much to our satisfaction—that quite as good plate glass can be made at home as can be brought from across the water. Some, not as cautious as ourselves, say that the home product is the superior. Certainly the demand for it increases about as rapidly as new factories can be built to supply it. The joint product of the two Creighton plants is nearly two hundred and fifty thousand square feet per month, or about seventy acres of plate glass a year! It takes some eleven hundred hands to turn out such a product as this, and its value is reckoned in the hundred thousands. Natural gas is used everywhere throughout both works, displacing, perhaps six thousand bushels of coal daily. Among other duties, it supplies steam for engines of probably not less than three thousand aggregate horse-power. The new factory, some miles to the east of Creighton, will have a capacity, when completed, of three hundred thousand square feet of glass a month. We should hesitate to introduce so many figures, remembering the general aversion to statistics; but they will present, better than anything else, a just conception of the magnitude of the operations connected with a large factory, and will perhaps dispel the notion—if such exist—that we are still largely dependent upon French dexterity for our supply of plate glass.

Such, in brief, is an outline of the three processes by which a pane of glass may be produced. Each day it becomes more perfect, until now there seems little further to hope for, unless it be that the glass might lose some of its readiness to break into pieces on the least provocation. Our windows are already as large as we care to have them, and so clear that, every once in a while, some unlucky soul ignores the fact that the window has any glass in it.

Such flattery as this encourages the glass-maker, in a double sense, to renew his efforts. It assures him of a continued demand, and also that his window-pane has fulfilled its highest function—in having been seen through, without being seen.

SOUTH SLAVIC MOON-MYTHS.

By Dr. FRIEDRICH S. KRAUSS.

THE South Slavic peoples have a number of popular songs reciting with many variations the theme of the wedding of the sun or the moon with the morning star or dawn. The relatives of these luminaries also play a part in the wedding processions, and appear variously as the nuptial dignitaries—Saint John, the thunderer Elias, and the holy Virgin Mary. The story runs along so plausibly that one can not tell by reasoning what is signified by the invocation of these higher beings; in other words, with all its clearness it is quite obscure. But the learned mythologist easily does away with all difficulties, and applies his artificial explanations with the greatest satisfaction. Parallels are easily drawn from Grecian, Roman, Indian, Germanic, or Lithuanian mythology, and the thing is done. The stereotyped conclusion of the mythologists is drawn to the effect that a people that entertains such speculations must have formerly had a high degree of culture, and have been of equal birth with the oldest civilized nations.

The answer to such talk is, that the stories of these sun and moon weddings have no support in the faith of the people, and are in no wise consonant with their other national and religious notions. Certain fables are indeed appealed to, that tell how the youth, in search of his ever-vanishing love, inquires in turn of the wind-mother, the sun-mother, and the moon-mother. But, to accept these in explanation, we have to pass off as specifically Slavic what is really and confessedly an all-world story, and in which there is, therefore, nothing significant of the South Slavic superstition.

It is not necessary to believe that there is any illusion in the matter. While the popular thinking is often illogical and takes poetry for truth, real misapprehension exists only among individuals, and the popular mind takes a fixed direction. Examination of the songs in which these moon-marriages are mentioned will show that they are exclusively lyrics or short songs, such as are sung by the processions at the bringing of the bride from the parental home, or which greet her as she enters the house of her spouse. The significance of the part played in them by the stars is explained by the popular custom of giving to the wedding-guests, particularly to those who have anything to do with the ceremonies, pet names by which they are called till the affair is over. A stereotyped name for the bride is Danica (the morning star), and for the groom Sunce (the sun) or Mjesec (the moon). The principal groomsman is addressed as Saint John; the god-father as Elias; the first bridesmaid as Mary; and the other guests usually receive names of flowers. The three chief personages after the bridal pair have generally the stereotyped name and a newly borrowed pet name. Evidently a poetical expression rules in these affairs, by which the figurative characterizations of the higher spheres of the sky have been adapted to the transferred names. Among the more than a hundred songs of this kind we cite one from B. Petranovic's collection of Servian popular songs, which relates how the suitor wakened the passion of his sweetheart:

"The morning star said angrily to the moon,
Where have you tarried, my bright moon, so long?
Where have you tarried, where have you idled the time?
Where I tarried I idled no time:
We were eating for you a supper of sweets;
We saw for you a maid as handsome as pearl;
Her hair was fragrant with sweet-smelling blossoms—
Oh, would that the flowers were for me!
Then jealous anger possessed the morning star,
And she speeded in rage over the clear sky."

The poetic imagery is, I think, perfectly comprehensible. It is of common application in popular verse. Let us recollect that every literature of the kind has only a comparatively limited stock of comparisons and figures, and that it is, therefore, obliged to make a narrow means suffice for all occasions. It does not readily waste its poetical material, and it is turned from its course only when the occasion is an extraordinary one. Metaphors drawn from the stars are still in full vigor, but find their complete adaptation only in poetry. But there is not a trace of mythological mysticism in it.

It may be observed, in explanation of the popular faith about the moon, that the people regard its regularly recurring decrease and increase wholly according to the apparently good or ill working of its phases upon the fortunes of man and the world. Of the phenomena themselves they have no settled opinion, although some incline to accept a fable which is peculiar to the Croats on the Steiermark border as a popular myth. I prefer to regard it as a part of the apocryphal folk-lore of the middle ages, or perhaps as of German origin. Saint Elias, as the national saint, lord of the highest mountains, lends it his name only to save the trivial story from ridicule. It runs:

The holy Elias once had a long leisure-spell, and went out walking. Coming to a small bay, he sat down and rested there for three days, till, getting hungry, he began to catch crabs and eat them. He relished them so well as to eat up nearly all there were. But God would not let this come to pass, and therefore raised a great wind that took the saint up into the air. He traveled through space for three days, and reached the moon in the night. Here the saint was punished by having to look down into the sea all the night long and see the crabs grow. Then so great hunger came upon Elias that he bit off piece after piece from the moon and swallowed them; and if God the Lord had not been gracious enough to order the moon to increase, the saint would have died of hunger after eating it, and have fallen to the earth and been broken into a thousand pieces. Yet God spared him and transplanted him to the moon; else he would have eaten up all the crabs in the sea, and at another time would have had only empty disappointment. Thus the moon decreases and increases according as the saint eats or fasts.

If we divest the fable of its unessentials, which may be set to the account of some unknown poet, there is left a feature of international folk-lore, viz., that sins have to be expiated in the moon. As in German superstition, so also in that of the South Slavs, the man in the moon is a desecrator of the holy Sabbath rest. Sometimes he is a wood-cutter, sometimes a blacksmith. The story reads that a wood-cutter, having stolen some wood in the forest on Sunday, was condemned to be a wood-destroyer in the moon for all eternity. He can be seen at full moon, sometimes with an axe in his hand, sometimes with a bundle of sticks on his back.

Another version tells that there was once a blacksmith who knew how to make skeleton keys with which one could open any lock, and, because he did this on Sundays and holidays, was condemned to work forever in the moon. It may be in deference to the conception of the ghost of Frau Mictlwoch, who was punished for desecrating a holy day by spinning, that a spinner is sometimes substituted for a man in the moon. The Swabians also find a spinner there.

A maiden was accustomed to spin late on Saturday in the moonlight. At one time the new moon on the eve of Sunday drew her up to itself, and since then she has sat in the moon and spun. And now, when the "gossamer days" set in late in the summer, the white threads float around in the air. These threads are the spinnings of the lunar spinner.

The moon is especially a weird avenger of human arrogance, and has its humors, according to which things go well or ill with it. In its waxing it has a special force and a certain good-will for the earth and its inhabitants, while in its wane it is friendly to no one. The good woman must not do any sewing in the decrease of the moon, for the stitches will not hold; farming-tools must not be left in the field, because, it is believed, if they are, crops will not again thrive there. If an unbaptized child is exposed to the moonlight, it will lose its luck for its whole life. If one points at the moon with the finger he will suffer from swellings around the nail; and whoever spits at the moon will lose all his teeth. These beliefs, too, are international. The same is the case with the religious notions about the new moon. Sorceries of every kind, to be successful, must be performed on Sunday night of the new moon. The hair must be cut only in the increase of the moon, otherwise there is danger of getting headache. If a person returning home in the evening sees the full moon, he ought to take some money out of his purse, and utter an incantation that will make it increase a hundred times during the month.

The moon is also supposed to have an influence over animals and plants. Cucumbers become very large by lying three nights in moonshine. Trees, of which it is intended to make timber for a house, must be felled only in the full moon, else some one in the family will die very soon. Sheep must be sheared in the increase of the moon, for the wool is then longest and most durable. Swine should be slaughtered at the same season, when they are at their fattest and in the most healthy condition.

What Tacitus says of the Germans, that they believe that certain things are best undertaken in the new moon or before its full, is also applicable to the South Slavic superstitions. In both German and South Slavic popular lore, the moon is only a fetich, and South Slavic belief at least affords no ground for the supposition that it is honored as a divinity; and I have no hesitation in declaring that the finely drawn speculations of Slavic mythologists respecting the moon are only learned but vain dreams.

We may remark, in conclusion, that peasants are wont to predict the approaching phases of the weather from the color of the moon. They have the belief that the moon is like a sponge, and can instantly absorb the clouds, and as quickly let them loose again to darken the sky. If the moon shines silvery clear, fine weather is at hand; if it looks reddish, there will be wind; and a pale moon is a sign of impending rain. Some believe that if the horn of the new moon shows a little spot, the weather at full moon will be foul; if there is no spot, it will be fair till the end of the month.—*Translated for the Popular Science Monthly from Das Ausland.*

Prof. Nehring believes that the dog is descended from various still-surviving species of wolves and jackals. It is not particularly difficult, he says, to tame jackals, and many attempts to domesticate wolves have been made in recent times.

COMPETITION AND THE TRUSTS.

By GEORGE ILES.

LAST autumn I happened to spend a few days in the heart of the Adirondacks, in a small village some fourteen miles from the nearest railroad-station. During the stage-coach journey I found that two of my fellow-passengers were commercial travelers. It was somewhat surprising to find them invading so remote an outpost of civilization, a hamlet at best, both expensive and troublesome of access. During my stay there, scarcely a day passed that did not bring the shop-keepers a traveling salesman from Albany, Boston, or New York. About a month before my visit, the principal merchant in the one straggling street of the place had been called upon one morning by no fewer than four solicitors of his trade. Could there be any better illustration of modern commercial competition than this penetration of the wilderness of northern New York by men who brought to the tents and cottages of a minor health-resort the latest fashions in dry-goods and millinery, the most recent products of mill, refinery, and cannery, romances fresh from the press? And, conjoined with the very palpable benefits of competitive enterprise, were not its wastes and burdens as clearly exemplified? While that far-away village was much advantaged by the keen rivalry to supply its wants, the efforts to secure its business were certainly not adequately repaid.

Fifty years ago so small a village, instead of several stores, would have had but one or two; their stocks chiefly bought from local makers of cloth, plows, stoves, and wooden-ware. Near by we would have had a shoemaker's shop, and perhaps, if the place were not too small, a tailor's as well. Twice a year the country store-keeper would go to the nearest large trade-center, New York, St. Louis, or New Orleans, and buy goods enough for the entire business of six months. Railroads and the development of steam manufacturing have changed all this. Small local cloth-weavers, stove-founders, and so on, have disappeared, for production is no longer profitable unless conducted on a vast scale. A cotton-mill now employs a thousand operatives instead of a hundred, while to build, equip, and launch a modern foundry demands the capital of a millionaire. The price of a staple article such as paper is now quoted to hundredths of a cent, and so slender have profit-margins become that in certain gigantic industries they consist solely in what a generation ago were deemed waste products. Many Northwestern flour-mills now find their dividend in the bran which used to be thrown away. From cotton-seed, until recent years accounted worthless, does the Southern planter derive a goodly proportion of his gains; and while increase of magnitude in industrial concerns tends to minimize the cost of management and to promote the economies due to the division of labor, we see a constantly growing specialization of industry. A few years ago combs formed part of a general variety of goods turned out by an India-rubber factory; now two large concerns exclusively devoted to comb-manufacture supply nearly the whole American demand. Immense factories of wooden-ware and tinware, fitted up with costly and ingenious machinery, have obliterated the small local shops which used to flourish a generation ago, and custom shoemakers and tailors are suffering from the constant encroachments of manufacturers whose wares are made wholesale at the lowest limit of cost. Low prices, due to cheapened production, have created large new home markets, as, for example, in the inexpensive pianos and reed-organs to be found to-day in the homes of all but the poorest.

Every commercial traveler's trim sample-case bears witness to the progress of a hundred arts and sciences employed to increase the supply of a luxury, to make articles of every-day use better and cheaper. Every can of peaches, every quire of paper, every yard of cassimere, testifies to some new achievement of ingenuity and skill. Does some alert mind in the great army of those who earn by serving devise some new and better way of manufacture, transportation, distribution? Rivalry quickly imitates it throughout the length and breadth of the land, to the general profit. In this unceasing economization of human effort the railroads have borne a leading part. Markets no longer mean those furnished by groups of States; the whole Union is now opened up to the enterprising manufacturer, no matter where he establishes himself; and the steadily decreasing freight-tariffs of the railroads are due not only to the growth of their business and to applied science in the details of construction and operation, but also to the economy which attends the unification of great systems. A closely printed page scarcely suffices to enumerate the lines operated by the Pennsylvania Company. From Vancouver to Montreal, a single management extends for twenty-nine hundred miles, and will soon, in reaching the Atlantic seaboard, span the continent.

The benefits of competition in manufacture and trade are so many and conspicuous that its losses and burdens are very apt to be disregarded; yet they are neither few nor insignificant. One class of them is the creature of steam, which, applied within recent decades to transportation and manufacture, has in the main been so great a source of public advantage. Forty or fifty years ago a weaver made cloth and a shoemaker boots for customers within a short distance of loom or shop, so that they could pretty accurately adjust supply to demand, and their shelves were rarely too heavily laden with wares. To-day, so rapidly have improvements in steam-machinery multiplied the output of factories and mills, that overproduction is their chronic case; and this overproduction is in no slight measure due to a fallacy into which sanguine men have been led by the rapid expansion of America's railroad system. Beyond the increase of market due to new populations attracted by this expansion, unwarranted expectations have been entertained. The mere aggregation of the small districts in which business was done in the past has been taken to mean an immense enlargement of the whole national demand, as if taking down fences were to augment the area of contiguous farms. Railroad extension means new rivalry quite as often as new customers. Woolens woven in Minnesota now compete in Massachusetts and Connecticut with goods of home production. Iron castings from Tennessee and Alabama are to-day entering Northern markets by virtue of freight-tariffs nominal in comparison with those of fifteen or twenty years ago. Now that the whole Union is merged as a single market, calculations with regard to competition are more difficult than ever before. A generation or two since under-supply was a common liability. To-day the opposite embarrassment of overproduction is the business man's problem as he surveys dislocations of industry as much more severe than those of his grandfather's time as the waves of the storm-beaten Atlantic exceed the ripples of a mill-pond. And evil has bred after its kind. Prior to 1878 Canada had a low tariff; the protective duties enacted that year were imposed chiefly because of overproduction in the United States. It was shown that Canadian manufacturing interests were demoralized through the Dominion being made a slaughter-market for the surplus stocks of American factories and mills.

Competition's systematic underselling is chargeable with the enormous losses which arise from adulteration. Consumers are usually poor judges of the purity or durability of what they buy, and the appearance of cheapness easily deceives them. When once adulteration has lowered a price, they resist the increase of it necessary to restore a sound standard of quality. Yet, as a rule, the great majority of those who practice adulteration are unwilling parties thereto. If a grinder of paints begins mixing sulphate of baryta with his white leads, his competitors must do the same. If a dealer in sirup dilutes it with glucose, in self-defense others in the trade must practice the same deception. The low prices brought about by such methods mean dear buying. Especially is this the case with textile fabrics. Cottons and woolens are not seldom deteriorated in wearing quality one half by admixtures which only reduce the cost of production one fifth; and greed has not hesitated to dilute and falsify the drugs employed to assuage pain and heal the sick and wounded. With this not only the intensity of modern competition but the width of its area has had something to do. One of the strongest moral checks in human nature is sympathy with suffering; but if aggravation of suffering be remote in place, uncertain in time, and unpublished, conscience is apt to slumber. A druggist to-day receives from scores of factories hundreds of preparations, concerning the purity of which he knows little or nothing. He dispenses them not to neighbors, but to customers, who, from the necessities of the case, must be strangers to him.

Not only in adulteration, but in other evils developed by competition, is the meanest man in a trade the lawgiver in that trade. A manufacturer or miner imports cheap Italian and Hungarian labor, thereby reducing the standard of living among his other work-people to the Italian and Hungarian level, and obliging his competitors to follow his example. A few firms who introduced child-labor into the manufacture of garments are responsible for the shrinkage in wages which of late years has steadily overtaken the entire seamstress class.

Adam Smith tells us that one of the elements of price is the higgling of the market—a pregnant observation concerning one of the grievous burdens of competition. We hear much about the frauds perpetrated by those who make and sell goods—we hear little concerning the frauds committed by those who buy; yet buyers and sellers are made of the same clay, and buyers not seldom grudge to pay a fair profit to the men who supply them. To illustrate: Let us suppose the firm of Robinson & Co. to be makers of thermometers, on which they set prices as just to their customers as to themsélves. They are accustomed to sell a tenth part of their output to a certain New-Yorker. He goes to them one day and says that, unless they reduce their prices five per cent, he will cease to deal with them. Although at a deduction from the profit fairly their due, they comply, simply because to refuse will result in larger loss than to submit. What one customer has done others may do, so that "higgling" may for a longer or shorter time force capable and industrious men to work without wages. Competition may be dreaded for just as well as for interested motives. A new rival may inflict severe loss through overestimating the business field which he enters; through cutting the price of a staple below cost, and making it what is called a "leader"; or through downright dishonesty and recklessness.

One of the remarkable developments of modern competition is in the matter of its costly and pervasive methods of solicitation. This, in the case of the commercial-traveling system, has had effects good and evil. While it brings the latest products of metropolitan taste and skill to the remotest and smallest settlements, its services, when ignorantly and chancefully directed, as in the case of the Adirondack village, result in waste and loss. An agent of shrewdness and fidelity can exercise a very valuable watchfulness over his principal's debtors, yet a system which tends to make a "connection" the property of an agent, transferable to a new employer, is not one to diminish the liabilities and cares of business management. But the chief evil of the oversolicitation which is so common is the undue cheapening of credit. While it continues to be as difficult as ever for a merchant to borrow money, there is nothing easier than his getting credit for money's worth in the form of goods. Whereas an old-time shop-keeper, in his face-to-face transactions with a wholesale merchant or manufacturer, explained why he deserved credit when he wanted it, nowadays persuading people to take credit, even for what they do not want and may not pay for, has become a fine art; while the investigation of the creditability of firms is the function of immense "commercial agencies." A step in the direction of sound business organization has been taken by the employment of commercial travelers to ascertain a demand before it is supplied. A manufacturer of hats or straw-goods designs a variety of styles for an approaching season's trade, and turns out the quantities ordered and no more. By similar methods many importers avoid carrying large stocks of goods, and are becoming more and more commission-merchants, or brokers, unburdened by the rent of extensive premises and the losses incidental to buying for chance sale.

In Great Britain, every year, more than a hundred million dollars' worth of goods are distributed at retail at a gross cost little exceeding five per cent. In New England the experimental imitations of British co-operation have transacted business at an expense one half more, 7·7 per cent. Retail distribution in America probably costs twenty per cent of the prices consumers pay, and, because of their utter absence of organization, the outlays for solicitation constantly grow. Conspicuous premises are leased at enormous rents to attract chance buyers. Windows are decked by artists whose skill is a specialty, invoking the aid of scene-painter and stage-mechanic. Newspapers are filled with adroit and reiterated allurements. Circulars repeat them; hoardings re-echo them. At home the bell-ringing army of hawkers and canvassers consume time which is money, and patience, which is more. Minor articles of use or beauty are gratuitously distributed, to remind us at every turn of the merits of some pill, soap, or insurance company. Who shall measure the cost of all this to the solicited, in distraction and annoyance? One of the most promising fields for American business enterprise I believe to be the organization of retail distribution, which, among other economies, can rid itself of the expense of solicitation. We have already great bazaars which combine the variety of a country store by assembling under one roof the special departments of ordinary city warehouses: is it not possible to organize for such marts stated circles of customers, on whose steady trade the proprietors can rely—circles sufficiently large for adequate support, independently of showy premises or other advertisement? Some such organization could offer customers lowered prices in consideration for their agreement to forego the luxury of buying at random. Some such improvement in retailing would make it possible to introduce certain advantages of British co-operation among a public who prefer individual enterprise to board-management. A buyer in Rochdale or London hears from a co-operative salesman the exact truth regarding the quality of his flannel, coffee, or gloves. The salesman has no interest in deceit, and money is expended to the best possible advantage. The profit which attends this replacing an antagonism of interests by an identification has been remarkably exemplified in New England by the factories mutual-insurance companies. These concerns insure more than four hundred million dollars' worth of mill-property, at one fourth the cost of non-co-operative underwriting.

Briefly to summarize them, the chief evils attendant upon competition are those which grow out of ignorance concerning what competitors are doing in a given field; the excessive cost of solicitation in its various forms and consequences; the absence of responsibility when business is in the hands of small firms; and lastly, the immense tax commonly included in the prices of retail sale. It was in the business of transportation that the losses attending unrestricted competition were first severely felt, and first sought to be remedied. Shippers, by adroitly playing one line off against another, were able to lower rates much beyond fair limits, especially when ill-considered rivalry or the profits of promotion and construction had created unnecessary roads. To prevent the recurrence of costly and sometimes ruinous tariff wars, agreements as to rates were made—only to be broken whenever it suited the interests of any one of the parties to do so. This experience at last led to the device of the pool, an ingenious attempt to retain the beneficial features of competition while discarding its evils. A pool, let us say, comprises four trunk-lines connecting Chicago and New York; their business for a certain period prior to the formation of the pool is ascertained to have been in the proportions of thirteen, eighteen, twenty-eight, and forty-one per cent. Freight is then apportioned in these ratios; but if the expressed desires of shippers would vary this allotment, it is maintained, nevertheless, by officers of the pool known as "eveners." When a second term of the organization is discussed, these shippers' preferences, as growing out of the improved management or facilities of a particular line, are given weight in a revision of ratios. Were pooling agreements legalized so that their terms could be enforced, Mr. Fink, the first railroad authority in America, declares that the principal step toward settling the railroad problem would be taken. In the great work which the Interstate Railroad Commission has accomplished, not the least benefit has arisen from the publicity it has given to complaint. It is now clearly proved that corporations dread condemnation at the bar of public opinion, and that they often have an unsuspected sense of responsibility which can be directed to curtail their abuse of power.

With a home market safe from foreign competition, with the steady swallowing of little fish by great, and the growth of these from great to greater, it was only natural that the policy which aimed to suppress what was deemed undue rivalry in transportation should be paralleled in manufacturing industry. Hence a few years ago we saw associations begun to be formed among producers of iron, steel, paper, salt, and other articles of prime necessity, all intended to regulate output and price-lists. As a rule, these associations did not work well. They lacked the means to punish breaches of faith to which superior facilities or management might tempt one of the associates. Some more substantial bond was called for if agreements were to be respected and harmony of interests maintained. Then arose the "trust," with its organic tie; an industrial creation nothing short of revolutionary. In the most approved form of "trust," such of the concerns to be affiliated as are not incorporated, are transformed into joint-stock companies. Then all the companies, new and old, transfer their property to the "trust," an unincorporated board which represents each of the unified concerns. The trustees then exchange "trust" certificates for the various companies' shares, usually on the basis of a trebled or quadrupled valuation. Control is then exercised by the board over all the operations of the industry thus organized; one refinery or mill is enlarged, another is closed; territory is apportioned to each active member of the combination, output is regulated, prices fixed. Let us mark the prize which tempts to this apparently perilous relinquishment of direct control of its affairs by each party to the union. We can see it best displayed in the case of the Standard Oil Trust.

No chapter in the history of American industry is more interesting than the record of the rise and progress of this "trust." Beginning in 1870 with an inconsiderable refinery in Cleveland, its founders took diligent heed of the fact of railroad competition: "special" rates were then commonly granted to any shipper who understood the profit which lay in "higgling." These Ohio refiners handled an article whereof freight was a large element of price; so, making "special rates" their opportunity or cover, they gradually succeeded in obtaining enormous rebates from ordinary terms, not only on the oil shipped by them, but on oil shipped by competitors. With this infamous advantage, the growth of their operations and of their power was rapid. Not many years elapsed before they were able to lay a pipeage system for their oil at a cost of thirty million dollars, supplanting the railroad system which had given them their chief impetus. In its struggle to extend and maintain its practical monopoly, the investigations of this "trust" at Albany and Washington disclose how the combats of swamp and jungle may be repeated in counting-house and exchange. Violence and fraud were employed to further the process of pushing rivals to the wall. Clerks were tempted to betray a competitor's confidence, workmen were bribed to explode his stills. To-day the Standard Oil Trust refines three fourths of the petroleum of the United States; fortunately, its interests chime with those of consumers, who therefore share in the benefits of its high and compact organization. The field of oil production constantly widens, bringing to market an increasing volume of crude oil; as the "trust" owns nearly all the transporting, storage, and manufacturing facilities in the country, it finds it best to make prices so reasonable that its sales may be the largest possible. This "trust" possesses almost every advantage which would inure to a state monopoly, managed by eminent ability at work for individual gain. It enjoys the immense saving which results from organizing the whole Union as a single market, whose wants can be systematically ascertained, and as systematically supplied from the trade-center of each territorial division. It reaps the gain which flows from so adjusting supply to demand that labor can be given uniform or nearly uniform employment, which comes from preserving credit from undue cheapening, and thus minimizing one of the chief perplexities of business—the estimation of risks. By unification of management, any new improvement in machinery or process is introduced at once into every refinery the trust controls. Mr. Dodd, one of the Standard's solicitors, declares its profits during 1886 to have been thirteen per cent, a much smaller return than that popularly supposed. It is worthy of note that the Standard people are now buying large tracts of oil lands, presumably with intent to control the production of oil as well as its distribution, refinement, and sale.

Incited by the success of the Standard, a great many "trusts" have been formed, imitating its methods in endeavoring to control the production of some leading article of trade. None of them, however, exhibit the ability of its management, or the sensitiveness to criticism and sense of public responsibility which have marked the Standard's later history. These "trusts" fall in the main into four classes—those which, like the iron and steel trust, are fostered by a tariff which excludes foreign competition; those like the envelope trust, which derive an additional element of monopoly from patented machinery and processes; those like the gas trusts, which are of *quasi*-public character, and operate under municipal franchise; and lastly, those which, like the Standard Oil and Cotton-seed Oil Trusts, depend solely upon aggregated capital and unified organization for their supremacy. That lowering the tariff would abate the excessive gains of "trusts" of the first-mentioned kind is proved by the sudden rise in the value of their certificates on the defeat of a national Administration pledged to tariff reform. In so far as abuse of patent-rights is made auxiliary to "trust" extortion, the curtailment or forfeiture of such rights, when so abused, becomes a subject demanding legal redress. With respect to "trusts" exercising *quasi*-public privileges, such as those of gas-supply, the remedy consists in municipal control, as convincingly maintained by Prof. E. J. James, of Philadelphia, in his treatise on the subject.

In considering the difficult questions which the advent of the "trusts" has created, it is necessary to discriminate between those which treat the public fairly and those which exact the utmost the public can be made to pay. If the Standard Oil Trust, disgraceful though its history may be, can prove that it gathers, transports, refines and sells petroleum cheaper than could the competitors whose place it has taken, what can be said against it? Its managers have built up a Union-comprehending organization, and are entitled to share in the results which flow from the economies they have perfected. Fairly managed, a trust is the last term in a process which began when a machine dispossessed hand-labor; which advanced when steam was applied to the machine; which took another step when steam-machinery, operated by massed joint-stock capital, undersold private firms. Industrial progress has steadily marched forward along the lines dictated by the economy of bigness over smallness, of high specialization, of the adjustment of supply to an ascertained demand, the constant substitution of knowledge of markets for ignorance regarding them, the unremitting elimination of chance. To many thousands of worthy men engaged in the rivalry with new methods they have meant defeat and ruin. This is pathetic but inevitable, for, when once men find out some better or cheaper way of doing a thing, they never go back to some costlier or more troublesome plan, no matter who suffers. Excluding then from all combinations to be pursued and condemned those which are controlled with fairness, we have to consider the best course to adopt with the conspiracies whose aim is nothing but the artificial raising of prices and impoverishment of the public. To cite two examples: Under "trust" control refined sugar is one half to three quarters of a cent per pound dearer in comparison with raw sugar than before the "trust" was formed. Raw linseed-oil, on the establishment of a "trust," was immediately advanced from thirty-eight to fifty-six cents a gallon. Against such extortion the remedy is first and chiefly competition. With capital for profitable investment abundant and cheap, no "trust" is secure in its control of the market. So rapidly and suddenly have the great majority of "trusts" arisen, that competition with them has not yet had time fully to manifest itself. To build and equip a sugar-refinery demands a million dollars and takes a year's time. In an industry such as that of sugar-refining, in which trust-control has been assumed only recently, such independent competitors as remain unincluded derive no little advantage from the "trust's" existence. They are free from regulation of their output, and find a ready market for all they manufacture by keeping their prices a mere fraction below the "trust's"—a condition of things certainly attractive to competition.

To curb and punish the plunderers who, turning their talons from their rivals, direct them upon the public, a variety of legal remedies have been sought. The most important recent decision affecting predatory "trusts" was that delivered by Judge Barrett in the Supreme Court of New York, January 10, 1889, in the suit of the people of the State against the North River Sugar-Refining Company, to dissolve the company and declare its charter forfeited for entering the Sugar Trust.

Judge Barrett's decision declared the charter forfeited and the company dissolved. The grounds of his judgment were that a corporation is liable to be dissolved by the abuse of its powers, or if it has exercised privileges or franchises not conferred upon it by law. He held that the directors of the corporations composing the "trust" had acted illegally in abdicating their direction in favor of the trust-board, to whom all shares of capital stock had been transferred. While corporations have no legal power to consolidate, the "trust" was practically a consolidation, which legally had no existence nor responsibility. He declared, further, that resting upon the inherent right of sovereignty, franchises are granted by the State on condition that corporate privileges shall not be abused, shall not antagonize the safety and welfare of the community. It was held proved that the Sugar Trust had not been formed for protection against ruinous competition, but for the illegal purpose of artificially enhancing the cost of a necessary article of commerce; that the "trust," by virtue of its combined capital and control, had power to crush any rival who, without equal resources, might enter the lists against it; and that, even if adequate competition with it were to arise, the delay incident thereto would be sufficient for intolerable oppression of the people. The case is to be carried to the Court of Appeals, and its fate there will be of national interest. In the courts of Ohio, Illinois, Louisiana, and other States, it has been decided that all combinations to suppress competition, raise prices, or restrain trade, are illegal, and it has been proposed to attack the "trusts" along the line indicated by these decisions.

Should the illegality of "trusts" in general, as now constituted, be maintained in courts of final appeal, the question emerges, How can the benefits of business organization, which the "trust" includes and has introduced, be secured with at the same time avoidance of abuse by a control practically amounting to monopoly? It is highly probable that, if corporations are denied the exercise of the economic and beneficial features of "trusts," firms attracted by the resulting advantages will establish organizations substantially similar. Indeed, individual accumulations of wealth have long since passed the point where they confer power to control single important industries of the United States. Clearly, then, a question of no little difficulty is before the American people. Ordinary competitive business has in many departments become so complex, unwieldy, and wasteful, as imperatively to demand some such simplification as "trust" organization offers. If that organization be denied to groups of capitalists, the powers sought by such organization will in all likelihood, with some delay, be exercised by individuals who will have all the temptation to abuse their strength into which corporations have been led in the past. Law must in the nature of things lag behind exigency, and in this new transition of business, from competition to combination, it evidently has to confront a problem of supreme importance. In the development of the Copper Trust we have seen how an international combination may become a conspiracy to rob the world: a singular piece of testimony to the obliteration of national boundaries by modern methods of locomotion and communication!

For "trusts" limiting their operations to the United States a line of treatment has been suggested which has doubtless had its origin in legal consideration of the railroad question. Since its settlement is stoutly maintained by expert authority to consist in frank acceptance of the "pool" and its legalization, why not, it is asked, also legalize the "trust," surrounding its control with all the safeguards necessary and feasible? The State already exercises a degree of supervision over certain *quasi*-public businesses—banking, insurance, and railroading. Its supervision may be justly extended to the "trusts," while at the same time the levy of a just tax will make the people sharers in the advantages of "trust" organizations. Their affairs published, their managers will have a better chance to cultivate a sense of public responsibility than at present, when, without status, their security threatened by attacks of all sorts, they seem intent on making the most of an opportunity which they expect to be brief. Because less in direct legislation than in residual competition lies the curb of extortion, this must be insured by strict enforcement of adequate laws against conspiracy. Were "trusts" legalized, it is said—did publicity attend their transactions—it would be both wise and profitable for them to make the public willing parties to their existence by employing their systematization of business to serve the public better than unorganized competition in the past has ever been able to do.

To this proffered solution of the "trust" question is opposed the objection that it involves an extension of governmental powers much in advance of existing evidences of governmental efficiency. Yet public control or restraint in some form is imperative. Whatever truth the self-regulating theory of private enterprise may have had in the days before combination, vanishes at a time when individual monopoly can levy a national tax in the shape of extortionate profit. However reluctantly we may admit it, more and more does exigency tend to enlarge the scope of State authority. Hence greater need than ever that public-spirited effort should purify politics, and endeavor to lift it to statesmanship. When the nation has been threatened by foes without or within, her citizens have ever given prompt response to the call for defence. To-day she seeks protection, not from armed invaders, but from economic oppressors. It is war again, but war demanding in its generalship not only courage in an unpicturesque field, but business sagacity of the highest order.

Knowledge of geography is important, says General R. Strachey, to the statesman, because upon it depend largely the right determination and definition of boundaries, the lack of which has been the cause of some of the greatest differences between states; to the soldier, for the intelligent planning of his campaigns, marches, and minor movements; to the engineer, who must have exact representations of the horizontal and vertical features with which he will have to deal, and knowledge of the climate, rainfall, and natural productions of the country; to the physician, who prescribes "change" to his patients; to the merchant, for the judicious dispatch of his wares; and to the emigrant, for a wise selection of his new home. Geography furnishes the key to the interpretation of many events of the past, and materials and aids in scientific research. Meteorology is largely indebted to it for the advance it has recently made. Without the aid which exploration has furnished, the generalizations of Darwin and Wallace concerning the origin and distribution of species and the influence of geographical conditions could not have been obtained.

LAW AS A DISTURBER OF SOCIAL ORDER.

By BENJAMIN REECE.

NOTHING is more perplexing to the inquiring mind than a contemplation of the great contrasts between the harmony and adaptation existing in the material world and the incongruities, antagonisms, and disorder which characterize the social and moral worlds. When one realizes how successfully the inventor and the artisan have followed the teachings of the scientist, he can not but suspect that much of our social unrest has arisen because our law-makers and philanthropists have not followed the teachings of social philosophy.

The fact is patent that, in the material world, where man's hand is powerless to interfere, there are perfect order and harmonious development; but in the moral and social worlds, which are always subject to man's petty and ill-considered meddling, we have great disorder and confusion. So marked are the incongruities of social condition that the philosophic thought which has failed to grasp the vital elements of development seems to be divided by the extravagant superlatives of pessimistic and optimistic expression. In his criticism of Mr. Herbert Spencer's essay, "Man *vs.* the State," Émile de Laveleye recognizes this uncertainty and want of harmony in human affairs, but fails to see that the disparities are caused by man's interference with the laws of his own being and development. He says: "Nature is subject to certain laws which are invariable, as, for instance, the law of gravitation. We may call these laws of nature, but in human institutions, which are ever varying, nothing of the sort can exist." He fails to realize that the law of gravitation is invariable because man's hand is powerless to change it, but directs its cunning to the construction of screws, levers, and inclined planes, in order to obtain mastery over nature.

Suppose the power had rested with man to substitute human contrivances for this unvarying law of nature, what inextricable confusion had resulted! Suppose the citizens of the vast territory whose commerce is tributary to the Northern chain of lakes should call upon their senators and representatives to devise ways and means by which to conduct their foreign trade direct from the lake ports, without first transshipping to, and thereby paying tribute to, the cities of the Atlantic coast. A physical difficulty at once presents itself, insomuch that the shallow-draught vessels of the lakes are unfit for ocean service, whereas the deep-draught vessels of the Atlantic are unable to enter the shallow waters of the canals and harbors of the lakes. After various consultations and debates, it is determined to correct this inequality of material nature by passing a law doubling the specific gravity of water in the lakes, so that ocean vessels drawing twenty-four feet of water can sail upon the lakes with little more than twelve. Is it not apparent that this single law would destroy the adjustment and adaptation of ages? Fish having been developed in water of normal density could no longer live in the lakes; the weeds and grasses which had grown upon the bed of the lakes would be uprooted by the water of double weight, to float upon the surface, and, being subjected to the sun's rays, would decompose and scatter the germs of pestilence and disease. The weight of water being doubled, it is made a little heavier than sand, so that the farms of sandy soils in Michigan and adjoining States would float away upon the waters of the lakes. Trees would be uprooted, the heavier clay soils, bridges, wharves, and railroad embankments washed away.

Then would follow an active period of legislation to neutralize the evil consequences resulting from the original interference with normal adjustments and relations. While seeking to retain all the advantages gained to commerce by the increased weight of water, law after law to restore the equilibrium would be enacted, and, where harmony and universal order once held sway, confusion worse confounded would obtain. That soils and lands might not be washed away, laws would be passed doubling their specific gravity, which would bring them nearly to the density of stone, rendering tillage very difficult and costly, while the seeds could no longer pierce through to the surface. In order that railway embankments might stand and resist these waters of such tremendous weight, the specific gravity of materials used in their construction is also doubled, but doubling the weight doubles the cost of handling and constructing, and the estimates of contractors and engineers prove worthless. Is it not evident that the waters of the lakes being doubled in weight leaves all other forms of matter correspondingly light, and the selfish propensities of men are at once aroused. Those interested in shipping desire water of increased specific gravity; those subject to floods demand legislation looking to a decrease in the weight of water; while the much-abused *doctrinaire* declares that the normal adjustments of ages upon ages could not be disturbed without disastrous consequences, for one law changing the relation of water to other forms of matter, makes necessary the passage of thousands of intricate laws in order to restore the equilibrium so ruthlessly destroyed, because of the vain attempt to enlarge the scope and power of one element without the corresponding diminution and weakening of all others.

In the contemplation of the material world, no discovery of science has worked more marvelous changes than the generalization known as the persistency or indestructibility of force; yet in the moral and social worlds its teachings are almost entirely disregarded. In exerting force in any form, it must be applied to something, and, whenever or however applied, that something will react with a force equal to and in an opposite direction to that which is applied. The man who lifts a hundred pounds' weight, finds the weight pulls one hundred pounds upon his arm; the man who strikes a blow, receives upon his fist a shock of equal force to that which he imposes upon the body of his antagonist: should he miss his aim, the direct force would react in a pull upon the shoulder, and might result in the dislocation of the joint. One pushes against an object until red in the face, but the redness of face and exhaustion are not caused by the direct application of power; it is because the object reacts in resisting or pushing with a force just equal to that which is applied; and, but for this pulling and pushing in reaction, men could apply force without expending force, could accomplish work without exerting energy, both of which are contradictions of terms and absurdities.

Notwithstanding this invariable law of nature, legislative enactments are daily made providing for the exertion of social and moral forces, without one thought of the reaction which must inevitably follow; and I may here say that Nihilism and political disorders in Russia are the reaction due to laws which restrict political rights; the agrarian troubles in Ireland are the reaction due to its onerous land laws; while our industrial unrest is but the reaction due to legislative interference with natural industrial forces.

The mechanic in moving large bodies secures the aid of lever, screw, or inclined plane, and is obliged to apply as much energy as the body offers resistance. In mechanics the principle of the correlation and conservation of forces is always acknowledged and obeyed; hence the unerring certainty of performance and the stability of the vast and intricate structures of the age. When large bodies are to be moved, physical energy is applied in the form of great power at low speed; where parts are to be severed, or fracture is sought, or where molecular instead of molar energy is desired, it is obtained by impact at high velocity, as is instanced in the firing of projectiles against a vessel's armor-plating: the energy applied is exhausted in penetrating the armor and generating heat, instead of imparting motion to the vessel.

In the social no less than in the material world, force is indestructible, and in the latter the hostile meeting of two unyielding bodies in collision arrests the molar energy to reappear as molecular with its equivalent in heat. So, if two social bodies meet and arrest each other's action entirely or in part, reaction follows in the form of irritation, passion, and vengeance, to which the French Revolution and other popular outbursts bear ample testimony; and these excitations of the inner man are exactly equal to the social forces in antagonistic equilibrium, and it is this form of energy which now gives rise to the warring tendencies and bitterness of classes.

But look at our legislation. Its presumed object is to move the whole social body upon higher planes of progress; yet it essays to urge forward this vast and intricate structure by the impact of quickening laws, by the concentration of social forces into certain lines; and to these ill-considered attempts can we attribute the present incoherent social state. The social organism fails to advance as a whole because power is converted into speed, and thus applied it has torn the social body into several parts. Capitalists and laborers, millionaires and paupers, moralists and criminals, are being urged upon separate lines with varying momentum, the acceleration of speed at the expense of power finally resulting in urging one tenth part of the population ten paces in advance of the masses, when, but for this transmutation of power into speed, the whole body of the people would have advanced one step together. If the few continue this heedless progress at the expense of the many, the separation will be more and more pronounced; and the wider the gap thus made, the more severe and disastrous will be the concussion in the day of readjustment.

Through the laws of force we learn that, when individuals or social groups pull together, the resultant is equal to the sum of their separate effects; but if they pull in opposition to each other, the resultant is found in the difference of their separate effects, and, should they be equal in power, equilibrium would ensue and no work could be accomplished.

Yet in spite of this unvarying law of nature, relentless war is being waged between the classes, causing social unrest and industrial turmoil; and, having been taught that in the ballot resides the remedy for all real and fancied evils, each class clamors for legislation, not to conserve the ends of justice, but to increase their own power or decrease that of the opposition, and thereby secure the object of their strife. Politicians discerning this incoherency of the body politic, are quick to take advantage of it by appealing to every selfish interest, hoping thereby to gain the honor and emoluments of place. In the mass of State and national laws daily enacted it would appear as if the American citizen, or society at large, is utterly disregarded. Of laws we have a surfeit, but they are aimed at voting groups and fail to comprehend the good of all: pension bills for soldiers, river and harbor bills for river and coast constituencies, protective tariff laws for manufacturers, labor legislation for workingmen, land grants for railroads, interstate commerce bills for shippers, subsidies for ship-builders, and oleomargarine bills for farmers—and yet the conflict rages, cries are raised against the arrogance and grinding avarice of monopolies, while bitter complaints are made of the domineering independence and unsteadiness of labor. Is it not evident that, if these selfish elements continue to repel forces which should be mutually attracted, the continued and increasing strain must result in violent and acrimonious rupture?

Most writers upon social science fail to grasp the fundamental principles underlying social growth. They seize upon half truths only, and according to their impressions they attach more or less importance to the egoistic or individual forces of character or to the tribal or social forces, as the case may be. Thus Mr. Leslie, in his introduction to De Lavelaye's "Primitive Property," claims to see nothing but strife and contention in the universal desire for individual property, and he urges with much spirit that it is not strange that all should desire to possess; but, says he, "what needs to be explained is that such warring elements, each desiring the same objects, should permit peaceful possession by others." Mr. Leslie fails to realize that such contentious forces must find some common base of action to escape from internecine strife; this is true not only of man, but of all gregarious animals. Even Mr. Clifford, in his "Scientific Basis of Morality," is disposed to view the social or tribal characteristics of man as the more essential to survival; but carried to its extreme, this submission to the wills of others results in the inaction of physical torpor, even as the extreme development of the individual traits of aggression result in the inaction of equal forces in conflict. Hence the two forces are correlated, and if they are separated by friction this civilization will perish, as its predecessors have done.

An analysis clearly shows that in the absence of extraneous interferences the reactive effect of individual aggression is resistance and social union, for which we find many forms of expression. Individual force is made manifest in the declaration of "I will do," "I will not do," while the reactive or social form finds expression in "I will or will not permit to be done." In the individual traits are found those activities which reside in purpose or in free will; in the social group we mark the modifications of environment sometimes called destiny or foreordination. Thus each individual is at the same time acting upon others and being acted upon by others, and, as action and reaction are equal and opposite, the aggressive force of all individuals is just equal to the resisting force of society in the aggregate. When these two forces develop in the same individual, we find law-abiding, just, and energetic characters; but when separated by friction, there are injustice, bitterness, and rancor. Upon this law does the development of society depend, and in the aggressive forces are found the elements of progress, while in the submitting and resisting forces are found the elements of stability. To the aggressive features of Western civilizations is due that rapid progress which has heretofore proved wanting in stability, while to the well-defined social conditions of Eastern caste is due the stability of the civilizations of the Orient, which have for ages lacked the elements of progress. Science formulates the theory, but not until taught by bitter experience does man seem to understand that by union and interaction we secure a resultant equal to the sum of our several activities, while by conflict and counteraction forces are neutralized, or at best the resultant can be no greater than the difference between the several effects.

The lowest races respect the rights of property among themselves. Mr. Darwin says of the Fuegians: "If any present was designed for one canoe, and it fell near another, it was invariably given to the right owner." It goes without saying that from the docks of one of our populous cities, in the midst of civilization, no such respect for the rights of others would be observed. But, in the state of ungovernable passion which characterizes the savage, is it not evident that a disregard of the personal rights of others would soon end in practical extermination, while by respecting the rights of others each gains security for his own?

It is idle to speculate as to the occasion of this nascent trust or confidence on which all societies rest alike in their infancy of ungovernable violence and in the maturer developments of the restraints and social order of our present civilization. It is true the stinted trusts of the undeveloped limit the duties they create, while the extended trusts of the more evolved imply the creation of new duties coextensive with those trusts.

Let us, for illustration, suppose that two savages, in pursuit of the same game, cross paths; immediately they turn upon each other; being evenly matched, neither gains the advantage, but the game escapes, their activities being lost in the attempt to thwart each other. With frequent repetitions they ultimately realize that to work with is more profitable than to work against each other, and the first step toward civilization has been taken.

It is reasonable to suppose that the first associations of men were intermittent and capricious, the bond of union being often severed at the will of either as personal advantage seemed to dictate, and that the discernment of the permanent blessings of social union was of slow and uncertain growth, and not until a long period had elapsed would the trust of either be so complete as to make treachery possible; for this augmenting trust is of mutual growth or dissolution, the former removing fears and stimulating reciprocal confidence, the latter leading to renewed watchfulness or inducing retaliatory aggressions.

Primitive man, being unrestricted except by the wills of others, would find himself in an environment in which his will would be moderated by the desires of others; and, whether the first bond of union had its origin in accident or experimental degrees of association, it is evident that, so soon as the advantages of the new conditions were experienced, the new duties involved in the new trust were readily acknowledged and willingly performed: and this coming together from a state of isolation, until by slow and gradual growth a visible bond of union was established, must have been a dual development, in which trusts and duties balanced, for mutual benefits give rise to mutual obligations, and not until a breach of duty revealed the existence of new dangers would an enforced compliance, much less a compact, be suggested.

"Do as you would be done by" is the natural inclination of man, and, though weakened and impaired by legislation, its many features still endure, for upon the operation of the golden rule does the permanency of all bonds of union rest. The dishonest gambler is watchful of the play, expecting to be cheated; he does not hesitate to cheat in turn, but he holds with sacred regard the debts of honor contracted at the table. The Texan cow-boy who shoots his man at sight would scorn to hide himself from the fury of an antagonist; careless in taking the lives of others, he is equally reckless concerning his own. The Indian neither extends to others nor hopes himself for mercy. The untrusting are unworthy of our confidence; thus love begets love, confidence inspires confidence, and with our higher types of manhood those superior to the law will transgress its mandates rather than violate their conscience, of which class we have records of many notable examples.

The whole history of human development is replete with the recognition of new duties, and the primitive bonds of savage union have been successively extended from families to tribes and clans, thence to states, which have further united into nations, while the final evolution points to a universal brotherhood. As previously stated, these two forces are met with everywhere—the active and the reactive, the positive and the negative, the aggressive and the permissive, the individual and the social—but they have been separated by legislation, much as you would separate the electricities by friction, and, as with the electricities, the like forces are repellent, while the unlike are mutually attracted.

Let us apply this law of nature to a well-known and familiar evil. I refer to joint-stock companies and corporations. The corporation of to-day differs from those of the Elizabethan period, in so far as such grants were then regarded as special favors, often conferred because of services to the crown, either promised or performed; while the joint-stock company of the present age is adopted as an institution, without any pretense of making returns to the state for favors received.

Every new era of material progress must be accompanied by its moral correlative, which is implied in trust, else treachery is sure to follow; and only as men enlarge their confidence can honest co-operation be extended. In the beginning of the present century, the age was ripe for co-operation in its industrial forms; and it would be the distinguishing feature of our present development, had not impatient legislation introduced the joint-stock company as a legal substitute. At the period of history to which we refer, the nobility still retained possession of the land, and deemed it vulgar to engage in trade; while the merchants had amassed large fortunes in the commerce which had sprung up from the daring explorations, enlightened navigation, and energetic colonization which followed the discovery of the mariner's compass. Small shops abounded; the master-workman, journeyman, and apprentice were friends and comrades, the apprentice becoming journeyman and then master-workman in turn. In the revolutionary struggles which marked the commercial age, a fair measure of free speech had been attained; and the scientist, being free to give to the world his discoveries, was quickly followed by the inventor, who applied these discoveries to the wants of man.

Is it not pertinent to inquire why, under such conditions, science, invention, and co-operation did not flourish and develop together; and why the scientist, the inventor, and the artisan, do not share the profits of their joint creations and endeavors, which profits are now largely absorbed by capital? How is it that, with enlarged mechanical possibilities, the small shop-owners have been driven from the field of proprietorship; and the master-workman and journeyman of a hundred years ago are to be found at the bench or lathe of the mammoth workshops of the day, not as independent workmen, but as mere automatons, to pull the levers which release the cranks, gears, and pulleys of the machinery which performs the former labor of their hands?

It is often urged, and with apparent seriousness, that in this republic every man has a chance to become the owner of one of these vast establishments! What monstrous folly to claim that every man can become the employer of a thousand men, when, by implication, for every proprietor there must remain a thousand men to be employed; so, with all the vain-glorious self-congratulation, it simply means that out of every struggling thousand one may reach the goal! Driven from so untenable a position, it is declared that the fittest will survive, which, being a half-truth, means nothing, for fitness has no existence apart from its environment. A cow-boy's fitness consists of quickness of sight and dexterity of hand. The savage depends upon skill in hunting and success in war. Fitness may reside in the longest purse, the lowest cunning, or the basest treachery, according to environment. The very fact that the possessor of wealth absorbs the profits of discovery, of invention, and of handicraft is sufficient reason to demand an inquiry as to what legislation has given us so distorted an environment.

The forces required for the industrial age are, first, capital, and, second, as in every other progressive step, an extension of trust or confidence; or, to use another form of expression, first, the individual forces, in which are found aggressive action or energy, thrift and prudence, all of which are implied in capital, but in such characters are often found wanting the true sense of justice—hence strong individuality may exist and still be distrusted and itself distrusting; second, the social forces, which are permissive, fair, honest, and just, all of which are essential to confidence—but these may all exist without energy, thrift, and prudence, which are implied in the possession of capital. Co-operation, then, is dependent upon a union of the social virtues which reside in confidence, and those personal morals which are typified in capital. Had these qualities been developed in the same individual, no laws would have been necessary to encourage combinations of capital to enter wider fields of production. The incentive to action is the expected reward, and in this case the inducement could be found in the large profits which combinations made possible.

If, then, at the beginning of the present century, the rich returns promised to those who would co-operate were fairly discerned, and in spite of such discernment men failed to enter into co-operative action, it is evident that moral and not material growth was essential to the true progress of the race, and any law looking to the stimulation of material agencies could not but impair and weaken the moral forces of development.

The fact that men of wealth would not combine for the carrying on of great projects which promised enormous profits, is evidence that they lacked confidence in each other, and to their minds treachery would surely follow trust. Upon the other hand, we find the artisans and mechanics then, as now, bound by the closest ties of fraternal friendship, born of mutual dependence and mutual trust; but they were wanting in those individual elements of character typified in the possession of capital: hence, so far as industrial pursuits were concerned, their trust and social qualities were without avail for want of money to make their combined efforts effective. We thus find that the rich men of that time, although able, were unwilling to combine, while the mechanics were perfectly willing, but unable for want of means. It must be plain to all thinking men that further moral development was absolutely essential, and, in the absence of legislation, an energetic moral growth would have followed a recognition of the permanent benefits to be derived by this further extension of trust. The rich, by fair dealing and strict integrity, would aim to prove their worth and show to their fellows that with added trust they would perform the corresponding duties. The artisans and mechanics would have been stimulated to energy and moved to thrift, prudence, and abstemiousness, in order to secure the capital with which to render their mutual trust available for industrial co-operation; and while ten men with ten thousand dollars became convinced of each other's worth, a thousand workmen would have saved one hundred dollars each, and in this manner in action and reaction each class would have developed the weak sides of its character, and, the growing integrity of the one meeting the increased energy and prudence of the other, would have gradually lessened the disparities of condition which then existed, instead of which we now find them constantly widening, and co-operation would have been the normal growth.

It is frequently claimed by the unthinking that co-operative unions are unable to select proper leaders for direction, whereas all history belies the claim. Whether in the playground, in the feudal ages, in times of great public peril, or in popular revolutions, the leader is recognized spontaneously, and the masses have seldom failed to make a wise selection. It is true that the co-operative concerns which have their origin in the hot-beds of experimental legislation have generally failed. But who shall say that failure would have resulted with the hardy plant which has been shown to be indigenous to the soil of the present age?

The natural evolution of material progress seemed too slow, and legislation was called into play to hasten the day of industrial activity. Since each class possessed one of the essential elements of industrial progress, it is evident that two ways were open to accelerate its growth. It could have been accomplished by providing the artisans of the age with government aid in money, in which way the state would have provided men a substitute for thrift, energy, and prudence; but government has no more right to do this than she had to furnish the rich a substitute for honesty and justice, and, as limiting the liability of the one has united dishonest elements and given additional power to the strong, so would and so has government aid in money led to a union of the shiftless and improvident and made still weaker those who for want of aggressive individuality have thus far failed to assert themselves; for, being provided with the results of energy and prudence, those qualities would no longer be developed in an environment which furnished them without effort or activity. We may here say that this method has seldom found favor with legislators.

As is usually the case, if legislation is to be invoked, it is generally in favor of those already strong in aggressive energy, and with these legislative aids the way is paved for the rich to become richer and the strong to become stronger. In this case the rich were furnished a substitute for confidence by a law which limited the duties and the liabilities of those combining, whereas it has been shown that in a healthy social state trusts and duties must be coextensive.

Legislators practically declared that, while they could not make men honest, they could establish confidence by so limiting the liability of those combining that honesty, instead of being an essential element of trust, would be inconsequential as an industrial force, for the possible chances of loss to the investor should be small. In this manner legislation pushed men together who would not be drawn together by mutual confidence; and society, having seen fit to trust those who would not trust each other, now complains of the insolence, injustice, and dishonesty of corporations! But, while denouncing corporations in unstinted terms, there are those who still regard them as a public blessing, essential to the times, but pray their legislators to deprive them of their sting, much after the manner of those who, while insisting upon the heavier waters of the lakes, would seek to legislate away the natural and inevitable consequences of doubling their specific gravity.

Those possessed of capital are entitled to its rewards. Those enjoying the confidence of others are equally entitled to its blessings. But, in providing the capitalist a substitute for confidence or trust, government neutralizes the forces which reside in honesty and justice, and makes inert as an industrial factor the trust and confidence of the poor.

Is there an enterprise of uncertain origin or doubtful purpose, it appears as an incorporated company. Firms upon the verge of bankruptcy, or about to take hazardous risks, change a partnership into a joint-stock company. Swindling patent-right, insurance, and mining schemes all take the form of corporations; but if the liability of a joint-stock company is limited, it simply means that the possible losses to society are without limit. An incorporated company with one hundred thousand dollars' worth of stock fails for eleven hundred thousand dollars; the company is liable for a hundred thousand dollars in addition to their stock, while the trusting public is called upon to lose a million dollars. Why, in the name of justice, should society give to corporations unlimited chances for profit, when, in case of loss or failure, society itself must bear the burden of all losses which exceed the limit of liability? If the corporation incurs debts exceeding its liability, legislation can never make those debts less; at best it but relieves the stockholders, and makes the trusting public stand the losses of the untrusting capitalist, and throws upon the shoulders of the innocent the debts of the careless or dishonest.

But the indictment against the corporation does not end with complaints of its arrogance and unjust and dishonest methods; but its impersonal relation to society and labor is a source of growing irritation, and threatens to make the labor question a most perplexing problem. In transferring the liability from the individual to the certificates of stock, personal responsibility was extinguished. The importance or standing of a stockholder no longer depends upon his wisdom, his uprightness, or integrity, but upon the amount of his stock; and, wherever the stock is found, there the authority and liability reside, notwithstanding the stock may be yours to-day and mine to-morrow. Corporations having no personality have neither moral nor social obligations, which are, or should be, imposed on all alike; but not only are they thus relieved of duties, but even the legal liability is a limited one only.

Stockholders, screened behind their stock, will vote measures toward their workmen which they would never dare to enforce as individuals, for then they would subject themselves to the moral condemnation which unjust and ill-considered action merits; but this impersonal relation of capital has introduced into our industrial system a state of affairs resembling that of absentee landlordism in Ireland, in which the manager acts the part of "my lord's agent."

The stockholders of a corporation may be scattered over every portion of the country or even throughout the world, and their interests are in the hands of managers who best show their worth by increased dividends, and, instead of serving as connecting links between capital and labor, they more frequently serve as severing wedges. It is by no means infrequent that men's wages are reduced dimes per day to increase the earnings, while the manager's salary is increased thousands per year as a reward for his fidelity. In this manner cheerful loyalty is giving place to a spiritless, sullen performance of duty. Is it any wonder that a bitterness is being engendered against capital as such?—for, when divested of personality, personal contact and, therefore, personal feeling are impossible. In the course of twenty years' experience, I have seen cheerful compliance grow into indifference, and that indifference gradually turn into feelings of smothered hostility.

This want of personality is also debauching public morals, and juries will render verdicts against corporations in spite of facts and the law. Interests which should be mutual, forces which should interact, are constantly arrayed one against the other, and the aggressions of the capitalists, who, through the medium of trusts and other devices, ruin their competitors and control prices, are confronted by the strong social forces made manifest in the close unions of labor, which find expression in frequent strikes and boycotts.

What, then, is the remedy? Various cures have been suggested, and, among others, some look to governmental control; but this would deprive us of aggressive individuality, in the same manner as the corporation has deprived us of the justice and honesty derived from natural trust and confidence. How may we retain the vigor and energy of individual push correlated with honesty and justice? Is it not plain that, with the restoration of personal liability, dishonest elements would scatter and their combinations dissolve?

It is asked, "What would then become of our great railway systems?" One thing is certain, although the impersonal corporation might vanish, the railways would remain, and there would be those to run them. If the persons united in the consolidated lines would trust each other (and if they will not, why should the public trust them?), such lines would continue as at present. If distrust should prevail, the Vanderbilts, for instance, might withdraw their capital from the West Shore, Michigan Central, Lake Shore, and other properties, and concentrate upon New York Central, leaving other capitalists to similarly withdraw from many properties, to concentrate and be responsible for one; and thus at one blow would be dissolved the mammoth consolidations which legislation has vainly aimed to check.

If, as would no doubt be threatened, our large manufacturing establishments should close, in a very short time the workmen would take possession, even as the liberated negro slave is now gradually becoming owner of the lands upon which he served in bondage. Trusts would scatter to the winds, for unfair and dishonest elements, no longer trusted by society, would prey upon each other, while the honest would withdraw, to unite among themselves. Material development might be retarded for a time, to make way for the moral growth essential to the proper conduct of industrial development. With this accomplished, co-operation would be an established institution, and the interests of capital and labor, now in constant conflict, would be united, and society would be rewarded by a resultant equal to the sum of their joint effects. Thus we have seen that in the industrial, no less than in the material, world action and reaction are opposite and equal, that force can neither be created nor destroyed, but, when it seems to disappear, it lives on, to reappear in new and equivalent effects.

AMONG THE FIJI ISLANDS.

By COUTTS TROTTER.

IT is a very trite remark that the Pacific Ocean often emphatically belies its title. I can not altogether defend it; and, in fact, it would be unreasonable to expect consistency from so vast an expanse of the unstable. When the grateful Magellan, escaping from the wintry horrors of the region now always associated with his name, burst into the sunshine and balmy breezes beyond, he did not, naturally, reflect very closely on the area over which the new name was to be applied. Big generalizations are dangerous; but it is not absolutely a misnomer, and those who have known this ocean for weeks together in its more gracious moods—whether on its vast solitudes or among its scattered island groups—will readily admit the justness of the title.

On the morning we reached Fiji the sea was without a ripple, and as we passed the pretty island of Mbengga, we scanned its rich green slopes in vain for a sight of life. Primitive man and his works do not show out prominently against tropical nature. A slight haze veiled the great island of Viti Levu—i. e., great Fiji; but, as we came nearer, its grand and varied outline stood out clearly in front of us, stretching far away to right and left. Suva, the seat of government, has no striking features. The houses lie scattered for a mile or two along a neck of land on one side of a bay, at the head of which enters the Tamavua River. A reef with a navigable opening crosses this bay, and forms a fair harbor. But the marvelous fantastic outline of hills beyond the bay—King David might have described them as "hopping"—seen from the broad veranda of the Club House Hotel, was a view of which one never tired. My expectations as regarded hotel accommodation being small, I was agreeably surprised to find a well-ordered, comfortable, two-storied house. It is true that the chambermaid was a little black Solomon Island "boy"; but his views on cleanliness, and on *meum* and *tuum*, were not appreciably behind those of his profession in Europe; and he was, besides, when at home, a man-slayer and a cannibal. The only drawback, indeed, to comfort lay in the fact that the bedrooms were all open to the roof of corrugated zinc, and the noise of the torrents of rain—I never saw rain like it—was deafening. But rainy days, at that season anyhow—well, at all events, it *is* the "dry season."

Boat-voyaging in those regions is not only an enjoyable, but in Fiji almost the only mode of locomotion, though there are horses, and the number of tracks has of late years been considerably extended. Organized facilities for travel do not exist; but the traveler's path will be smoothed if he brings introductions to some leading official, or to one of the principal traders or planters. If he wisely cultivates the society alike of the official and of the non-official class, he will realize more profoundly than he ever did before the great truth that there are two sides to every question. To this unfortunate antagonism I shall return later. Meanwhile I recall, with mingled sensations, a voyage of a fortnight in an open boat along the northern shores of Viti Levu, the principal island of the group, and about eighty by fifty-five miles in extent. The preparations for such a voyage are at all events simple. Of personal luggage the less the better—say a change of raiment and a mosquito-net, or "screen" as they call it in the colonies; for provisions, besides a tin or two of biscuits, some tea, whisky, and tobacco, you require only an assortment of the useful but most innutritious "ironclad"—i. e., tinned meats, here in universal use, and curiously in great demand among the natives, probably owing to the little trouble they involve. Hardly a coral strand in Fiji so romantic or remote but it may be found strewed with the empty tins. Judging from their effect on myself, I should cite them as a most potent cause of the decline of the native population!

We started punctually, *Vaka Viti**—that is to say, having been trysted on board for Saturday at daybreak, we got under way on Monday afternoon. Indeed, only a man of exceptional energy like my conductor could, I was assured, have performed such a feat. Meanwhile the delay had nearly led to our spending a night *al fresco* on the Rewa River, whose famous mosquitoes would have left little of us to tell the tale. These Fijian rivers are of great size relatively to the extent of the land, and the delta of the Rewa forms the eastern extremity of the island. We had intended, accordingly, entering by its southern mouth, some miles distant from Suva, to ascend the stream some way, and thence down another embouchure to the northern coast. As it was, night overtook us soon after entering the river; and, although we at last sighted a light which indicated a house, there was much grounding on mud-banks, and retracing of our course, and weary hours of pulling, before we reached the desired point. My host being on an official tour, and thoroughly acquainted with the people and their language, there was but little difficulty about our reception anywhere—not that any respectable traveler could have much difficulty among these amiable people. Hospitality here, after all, is a simple matter, for native food is plentiful, and there is usually room for everybody, besides that the chief of the village has often more houses than one.

* Fiji fashion, according to Fiji notions.

The ordinary Fijian house looks, outside, like a great oblong hay-stack, standing on a mound raised some few feet above the surrounding level, with a long ridge-pole extending beyond the roof at either gable, its ends sometimes ornamented with shells. The hay-stack has a doorway or two, with a mat suspended in it. Houses with greater pretensions, however, have the walls prettily latticed with reeds, and distinct from the roof, which is elaborately thatched, with great projecting eaves. Inside, immense posts, usually of *vesi*-wood (*Afzelia bijuga*), and a very ingenious framework, support the roof. The interior decorations of sinnet (cocoanut fiber), always in rectilinear patterns—for they do not affect curves—are sometimes pretty. The black, squared lintels of the doors are the stems of tree-ferns. On a great shelf overhead is stored the family *lau*, a convenient Fijian word equivalent to the Italian *roba*. Here it comprises their fishing-gear, huge rolls of *tappa* or native cloth, mats, immense pottery vessels, and the like. The shelves were also handy in war-time as a point of vantage whence you could conveniently spear your neighbor as he entered, and before his eyes became used to the subdued light. The floor is strewed with mats, on which you recline, and is usually raised a foot or so toward one end, which enables you to take a graceful attitude, leaning on your elbow. Cooking is done in a little hut outside, or sometimes there is a great fireplace on the floor, confined by four logs, the smoke finding its way out through the lofty roof. As you enter the house, you find the mats being swept, or fresh ones unrolled and laid down. Your traps are brought up from the boat, and, if this happens to have grounded half a mile from the shore, you have perhaps yourself been carried to land by these willing giants. A few words are exchanged with the village chief or your host for the time being—far too few, to my mind, even for politeness. I am told they do not expect it. If they have ceased to expect politeness from English gentlemen, *tant pis!* I am helpless from ignorance of the language, and you hardly ever meet a Fijian who knows any English—the missionaries, in whose hands their education has been, having, wisely or otherwise, discouraged it. The silent *séance* then till supper came, and indeed after, surrounded by those pleasant and dignified faces, for whom I was necessarily dumb, was often very irksome. Supper, however, comes at last, provided from the materials before mentioned, and supplemented perhaps by an offering of fish or turtle. The latter sounds sybaritic, but it is very far from being a delicacy when badly cooked, and still less so when not quite fresh. And there is of course, as accompaniment, the ever-present and ready-cooked yam, or *kumara* (sweet-potato), or *dalo* (an arum-root), or bread-fruit, or cassava (manioc). I think I have arranged them approximately according to their insipidity and unsatisfying qualities. I tried hard to appreciate these famous vegetables, whose very names recall endless picturesque and savage associations; but I never succeeded, and hardly know which I disliked the least.

Sometimes we produced a root of *kava*, or, as the Fijians call it, *yanggona*, always a welcome gift, and handed it to our native companions to prepare the national brew. I suppose most people by this time know the orthodox mode of preparing this. It is chewed, or ought to be, as in Samoa, by young and of course pretty girls, and the masticated stuff being thrown into a bowl and mixed with water, the woody particles are fished out with a wisp of the fiber of *vau* (a malvaceous tree, *Paritium* sp.), and the liquor is then carried round to each guest in order. Of course, by the old school this mode of preparation is thought very superior to the Tongan innovation of pounding or grating the root. Certainly, the ingredients differ somewhat, and the dash of human secretion in the orthodox mixture possibly promotes digestion—an effect not to be despised after a square meal of half a dozen pounds of yam! Even in the humblest *ménage* the national bowl is not prepared without some form and circumstance—elaborate traditional motions of the hands in clearing the bowl and rinsing the fiber, strict attention to precedence in handing the cup to the guests (a matter in which, when Europeans were concerned, I was in other islands sometimes consulted), and to other points of etiquette, the transgression of which is viewed with some severity. Thus, it is *de rigueur* to empty your cocoanut cup at a single draught. On my first occasion of drinking I had neglected this rule, for the cup was large, and the taste, as I thought, nasty. Accordingly, on returning the cup, which you do by sending it spinning along the floor to the master of ceremonies, the usual quiet clapping of hands and murmur of applause which should follow this were withheld. On discovering the cause of the silence, I hastened to explain that I had never tasted the cup before, and thought it so good that I could not resist prolonging the pleasure, but I saw that my solecism was too great to be easily excused.

The *kava*-bowl, tobacco, and family prayers exhaust the evening's programme; and my companions being all asleep—why people waste so much time in sleep in this interesting world I never understand—I look out some suitable rafter whence to hang my mosquito-screen, and turn in—not, for the first night at all events, to sleep, for Mother Earth, considered as a mattress, is hard, and deficient in spring; but there is, anyhow, no other impediment to sleep; the cleanliness inside the houses is remarkable—no fleas or other vermin bred of dirt or carelessness. Flies and mosquitoes are supplied by Providence, and the latter have recently been discovered to be "good for us"; but as you listen to their baffled drone outside the curtain, you feel that you can waive your claim to such advantages.

I attended, at the Vale-ni-Bose or council-house of the province of Ba, a half-yearly meeting of the chiefs, who assemble to discuss the affairs of their respective districts; and, though my interpreter gave me only an outline of what was going on, it was impossible not to be struck by their readiness and intelligence, and not less by their gravity and gentlemanlike manners. Among other incidents, some men were brought up who had tried to leave their district without permission for another; and the utter humiliation of their look and voice, coupled with the dignity and severity in tone and bearing of the chief's reprimand, was very dramatic. To be sure, not very long ago he might have ordered them to the oven!

This same *Roko* or high chief, a shrewd-looking man with a refined and well-shaped head, related with much humor how, on a certain occasion, when a missionary was coming through, and the people were sending in offerings to him, his (the *Roko's*) contribution was a "long pig"—i. e., a human body. He and the missionary, he said, have met since and discussed—I mean, talked over—this practical joke. He invited me in the evening to a *mekké*—i. e., *soirée musicale*. The singing was a weird and curious performance, which has a strange fascination. There were about fifty performers, comprising, in fact, the entire party present. One man begins alone, and after he has sung a few bars, another takes it up in a sort of second to him; then a few more join, till suddenly the whole body of voices strike in, accompanying the song with strange, unintelligible gesticulations, turning half round (they are all seated on the ground), and pointing at each other with intent, meaning looks, and occasionally all clapping hands, in absolute unison—the song ending unexpectedly and quite abruptly with one clap. The time is beaten by a man with a couple of small sticks; it was very intricate, and the music evidently genuine and old, unlike anything I ever heard, and not to be rendered by our notation. *Yanggona* followed—a serious ceremonial brew—and I acquitted myself well, emptying the cup at a single draught, the *Roko* afterward presenting me with his own bowl, which was considered a great compliment.

Having asked Sailosi, the provincial scribe, a very nice fellow, whether I could see some national dancing, I was told that it would hardly be worth my while, as there were only girls here to dance. I, of course, protested against this "only" as not merely ungallant but inapplicable, so far as my tastes were concerned; but it turned out that the scribe knew best, for the young ladies' performance was not very interesting, and it was very long. A few of the smaller girls, with a *lali* or drum, formed a group, while the rest in one or two rows kept walking slowly round them, singing in admirable time, far better than usually in church or school, but quite monotonous as to tune. Their costume was only the simple *sulu* or waist-cloth, but there were no really beautiful figures among them. Little bonfires were made to light up the performance, and the groups of small children tending these, or improvising torches, which they held with the greatest gravity and patience, was the most picturesque part of the scene. At last, when the young ladies had evidently exhausted their *répertoire*, and were beginning to repeat themselves, I slipped away, when Sailosi followed and begged me to stay, as he had arranged for a men's dance, and it was just coming on. Accordingly, they arrived and took possession of the ground; and the girls, after walking and chanting round them for a minute or two, as if by way of protest, gave it up and seated themselves among the spectators. It must be admitted that the new performance was a very superior affair. The dancers, fine stalwart fellows, gave first some of those curious combined movements, either simultaneous and in marvelous unison, or sometimes passing down a long line as if to represent the motion of a wave: then there were some capital figures, vigorously and beautifully danced, alternate rows dancing with regular steps in opposite directions, then setting to each other and wheeling round. I should not venture in "Maga," or indeed elsewhere, to hint that it was an improvement on a reel, but it recalled one in many of its features, including the occasional shout.

At Naiserelangi, another town on the north coast, where a half-yearly assemblage of chiefs was sitting, I had the good fortune to see some very picturesque and interesting ceremonies. These consisted of the customary offerings made by the people of the neighborhood to the visitors who had come from other parts of the district. Groups of these—splendid-looking fellows many of them—sat squatting in expectation on a space near the chief's house; while down the various paths leading to the village picturesque files of men and women came streaming on, carrying, either in their hands or on poles slung over their shoulders, bunches of every size of yams, or *dalo*, or pigs, or turtles. The procession had certainly not been marshaled with a conscious eye to the picturesque, and yet no artist or stage-manager could have produced an effect more perfect as to grouping, form, and color—the long rows of pleasant or stalwart figures ending off with little children, each gravely carrying its little offering, a single fruit, perhaps, or an egg; while for background to the picture rose a gently sloping hill-side, half wild, half planted, and crowned by precipice and forest. The bearers came up and deposited their burdens before the party of visitors, some one of these laying his hand on each heap in token of acceptance; and then followed a gentle clapping of hands, or of some other naked part, either in unison or a sort of running fire, but in a quiet ceremonious manner, as indicating formal rather than enthusiastic approval. Then the immense heap was divided into portions by a *mata ni vanua* —a hereditary official combining the duties of herald, embassador, and master of the ceremonies—who then proclaimed the name of the place for which each portion was destined. This is obviously a very delicate, not to say critical, operation, and to perform the division to the general satisfaction requires tact and discrimination of a high order. Finally, the parties representing each of the places named stepped forward and carried off their allotted portions. There is considerable feasting on these occasions, and sometimes, with such vast piles of food, considerable waste. They are enormous eaters, and constantly at it. One morning our share of the offering was brought in—a turtle and a mountain of *dalo*, then a little later a pig and another vast heap of *dalo* and yams; and before evening our crew of five had accounted for it all, with the very slight assistance we could give them; but the national vegetables have, of course, very little substance. Sometimes one sees fine-looking poultry and even turkeys, and one often gets very fair fish.

The sea, indeed, in some places, teems with life. You sail through masses of little white jelly-fish, or of a larger brown kind, besides a magnificent species of a rich purple color. Then there are multitudes of a diminutive flying-fish which I have not seen elsewhere. To the usual perils of the deep must here be added the shoals of gar-fish—a creature usually some fifteen inches long, with a long, sharp, bony snout—which at times take to whizzing through the air in all directions. You can not avoid them, for you can not tell from what direction one may be coming, and the snout, if it hit you fair, would go through your face or give a very ugly wound. One of our crew was struck and wounded, but he only threw the fish to the bottom of the boat, and said quietly, "I shall take it out of you for this to-night." A woman in the neighborhood had recently been struck by one in the breast, and died of the wound. A curious sight I saw one day, which I could not understand. Two large fish rose together about a yard from each other, shot straight up into the air, and then, sheering off in opposite directions, fell into the water a long way from each other. I asked what this meant—had they quarreled? "No," said one of the sailors, "it is not that. I have seen it before. It means a fair wind to-morrow." So next day, the wind being the reverse of fair, they put him into the bows to get the benefit of the water as it broke over us—hardly the way to encourage a study of natural phenomena!

The Fijians are a grand-looking race, splendidly made, and well proportioned from head to foot—no falling away about the calves, or spur-like heels, as one sees in some of the finer Indian races. Then such a carriage—broad shoulders, with the head well set on and thrown back. The mop head of hair, composed of long, separate spirals carefully tended and frizzed out, which is so special a characteristic of the race that till lately it was thought a natural peculiarity of the hair, is now unfortunately going out of fashion. It gives a very imposing appearance to the wearer, like a gigantic Guard's "bear-skin," but is now curtailed to the modest dimensions of four to six or seven inches in length. It is often dyed to a yellowish brown by a weekly plastering with lime, which also stiffens it, and is very becoming, though its primary use is to destroy the superabundant insect colonies. Any actor wishing to acquire the gait of conventional majesty should come out here and watch the ordinary Fijians walking up and down, every inch a king, and, in quaint combination with this majestic strut, holding each other's hands like little children. In color some few are very black, but the great majority vary from a dark bronze to *chocolat Ménier;* and one is often inclined to wonder whether the ancient use of bronze in statuary was suggested by the coloring of some such race. Certainly in this color humanity may go naked and not be ashamed. The costume proper is only the *sulu,* or waist-cloth; and there can be no better proof of the Fijian's natural dignity and look of breeding, than that the too frequent addition of a dirty flannel shirt does not always transform him into a ruffian or a snob. When a black coat and trousers are superadded —happily this is still very rare—as much can not be said!

The mysterious question of a general decline of these races has often been discussed, and has been ascribed to many causes, all of which contribute something, and some of which, as drink and debauchery, are obvious. Hardly less so, perhaps, the going to church in a full suit of European clothes, and sitting naked in a draught to cool themselves afterward! For this reckless introduction of clothing, not less deleterious than unæsthetic, the more ignorant missionary of former days has to answer, and disease has not unfrequently been introduced, besides, in second-hand clothing.

One hopes against hope, and against such experience as one has, that the decline of the Fijians will be arrested. The disappearance from the earth of these very fine races—for the Polynesians are finer still, perhaps the finest-looking race anywhere— is a distinct loss to the world, and not merely from a sentimental or antiquarian point of view. The experiment of preserving such a race has certainly never been tried before under such favorable circumstances, for the workers have had *carte blanche;* but it would not be surprising if, feeling they are fighting a losing battle, they began now to relax their exertions. It was melancholy to look at the registers of the little towns, neatly kept by native scribes, and to observe the gradual decrease—if fewer deaths sometimes, then also in proportion fewer births. One noticed, too, the hopeless resignation of the sick, suffering from comparatively slight ailments, but apparently not caring to live. If something more could be done in the way of giving skilled attendance to the sick, it would be well. An attempt is being made, by giving some little training in the hospitals, but the hamlets are so numerous, and so small and scattered, that it would be difficult for such trained attendants to reach them all. More might, as it seemed to me, be done in the way of sanitary supervision. The head-man or the district chief may be "responsible," but he may not always understand what is needed. Where sites are unhealthy they should be changed, and far greater cleanliness in the surroundings insisted on. (The interiors of the houses, as I have said, are almost faultless in this respect.) Direct encouragement might be given in some form for the rearing of children. The possession of an illegitimate child being now a proof of a crime which is punishable by law, such children, naturally, seldom see the light. But what I believe is needed, above all, is some additional stimulus to exertion, some interest in life which would strengthen their hold on it. With our accumulated experience, our great resources, and unlimited good intentions, is the problem beyond us?—*Abridged from Blackwood's Magazine.*

THE FOUNDATION-STONES OF THE EARTH.*

By Prof. T. G. BONNEY.

DO we know anything about the earth in the beginning of its history—anything of those rock-masses on which, as on foundation-stones, the great superstructure of the fossiliferous strata must rest? Palæontologists, by their patient industry, have deciphered many of the inscriptions, blurred and battered though they be, in which the story of life is engraved on the great stone book of Nature. Of its beginnings, indeed, we can not yet speak. The first lines of the record are at present wanting—perhaps never will be recovered. But, apart from this: before the grass and herb and tree, before the "moving creature in the water," before the "beast of the earth after his kind," there was a land and there was a sea. Do we know anything of that globe, as yet void of life? Will the rocks themselves give us any

* An address delivered before the British Association for the Advancement of Science, at the Bath meeting, September 10, 1888.

aid in interpreting the cryptogram which shrouds its history, or must we reply that there is neither voice nor language, and thus accept with blind submission, or spurn with no less blind incredulity, the conclusions of the physicist and the chemist? The secret of the earth's hot youth has doubtless been well kept; so well that we have often been tempted to guess idly rather than to labor patiently. Nevertheless, we are beginning, as I believe, to feel firm ground after long walking through a region of quicksands; we are laying hold of principles of interpretation, the relative value of which we can not in all cases as yet fully apprehend —principles which sometimes even appear to be in conflict, but which will some day lead us to the truth. The name Cambrian has been given to the oldest rocks in which fossils have been found. This group forms the first chapter in the first volume, called Palæozoic, of the history of living creatures. Any older rocks are provisionally termed Archæan. These — I speak at present of those indubitably underlying the Cambrian—exhibit marked differences one from another. Some are indubitably the detritus of other, and often of older, materials—slates and grits, volcanic dust and ashes, even lava-flows. Such rocks differ but little from the basement beds of the Cambrian; probably they are not much older, comparatively speaking. But in some places we find in a like position rocks as to the origin of which it is more difficult to decide. Often in their general aspect they resemble sedimentary deposits, but they seldom retain any distinct indications of their original fragmental constituents. They have been metamorphosed, the old structures have been obliterated, new minerals have been developed, and these exhibit that peculiar orientation, that rudely parallel arrangement which is called foliation. That these rocks are older than the Cambrian can often be demonstrated. Sometimes it can even be proved that their present distinctive character had been assumed before the overlying Cambrian rocks were deposited. Such rocks, then, we may confidently bring forward as types of the earth's foundation-stones. I must assume what I believe few, if any, competent workers will deny, that certain structures are distinctive of rocks which have solidified from a state of fusion under this or that environment; others are distinctive of sedimentary rocks; others, again, whatever may be their significance, belong to rocks of the so-called metamorphic group. Our initial difficulty is to find examples of the oldest rocks in which the original structures are still unmodified. Commonly they are like palimpsests, where the primitive character can only be discerned, at best faintly, under the more recent inscription. Here, then, is one of the best which I possess—a Laurentian gneiss from Canada. Its structure is characteristic of the whole group; the crystals of mica or hornblende are well defined, and commonly have a more or less parallel arrangement; here and there are bands in which these minerals are more abundant than elsewhere. The quartz and the feldspar are granular in form; the boundaries of these minerals are not rectilinear, but curved, wavy, or lobate; small grains of the one sometimes appear to be inclosed in larger grains of the other. Though the structure of this rock has a superficial resemblance to that of a granite of similar coarseness, it differs from it in this respect, as we can see from the next instance, a true granite, where the rectilinear outline of the feldspar is conspicuous. Here, then, is one of our problems. This difference of structure is too general to be without significance. What, then, does it mean? Among the agents of change known to geologists, three are admittedly of great importance: these are water, heat, and pressure. The first effect of pressure due to great earth-movements is to flatten somewhat the larger fragments in rocks, and to produce in those of finer grain the structure called cleavage. This, however, is a modification mainly mechanical. It consists in a rearrangement of the constituent particles; mineral changes, so far as they occur, being quite subordinate. But in certain extreme instances the latter are also conspicuous. From the fine mud, generally the result of the disintegration of feldspar, a mica, usually colorless, has been produced, which occurs in tiny flakes, often less than one hundredth of an inch long. In this process a certain amount of silica has been liberated, which sometimes augments pre-existing granules of quartz, sometimes consolidates independently as micro-crystalline quartz. Simultaneously carbonaceous and ferruginous constituents are converted into particles of graphite or of iron oxide. As to the effects of pressure when it acts upon a rock already crystalline, there are, as it seems to me, differences in the resultant structures which are dependent upon the mode in which pressure has acted. They are divisible into two groups; one indicating the result of simple direct crushing, the other of crushing accompanied by shearing. In the former case, the rock-mass has been so situated that any appreciable lateral movement has been impossible; it has yielded like a block in a crushing-machine. In the latter, a differential lateral movement of the particles has been possible, and it has prevailed when (as in the case of an overthrust fault) the whole mass has not only suffered compression, but also has traveled slowly forward. Obviously, the two cases can not be sharply divided, for the crushing up of a non-homogeneous rock may render some local shearing possible. Still, it is important to separate them in our minds, and we shall find that in many cases the structure, as a whole, like the cleavage of a slate, results from a direct crush; while in others the effects of shearing predominate. The latter, accordingly, exhibit phenomena resembling the effects of a tensile stress. Materials of a like character assume a more or less linear arrangement; the rock becomes slightly banded, and exhibits, as has been said, a kind of flexion structure. The mass gradually assumes a fragmental condition under the pressure, and its particles, as they shear and slide under the effects of thrust, behave to some extent like those of a non-uniform mass of rock in a plastic condition, as, for example, a slaggy glass. Illustrations of the effects of direct crushing in a granitoid rock are common in the Alps. Those of a shearing crush are magnificently developed near the great overthrust faults in the northwest Highlands of Scotland. It seems, then, to be demonstrated that by mechanical deformation, accompanied or followed by molecular rearrangement, foliated rocks, such as certain gneisses and certain schists, can be produced from rocks originally crystalline. But obviously there are limits to the amount of change. To get certain results you must have begun with rocks of a certain character. Hitherto we have been dealing with rocks which were approximately uniform in character, though composed of diverse materials—that is, with rocks more or less granular in character. Suppose, now, the original rock to have already acquired a definite structure—suppose it had assumed, never mind how, a distinct mineral banding, the layers varying in thickness from a small fraction of an inch upward. Would this structure survive the mechanical deformation? I can give an answer which will at any rate carry us a certain way. I can prove that subsequent pressure has frequently failed to obliterate an earlier banded structure. In such a district as the Alps we commonly find banded gneisses and banded schists which have been exposed to great pressure. Exactly as in the former case, the new divisional planes are indicated by a coating of films of mica, by which the fissility of the rock in this direction is increased. The mass has assumed a cleavage-foliation. I give it this name because it is due to the same cause as ordinary cleavage, but is accompanied by mineral change along the planes of division, while I term the older structure stratification-foliation, because so frequently, if it has not been determined by a stratification of the original constituents, it is at any rate a most extraordinary imitation of such an arrangement. In many cases the new structure is parallel with the old; but in others, as in the "strain-slip" cleavage of a phyllite, the newer can be seen distinctly cutting across the older mineral banding. To put it briefly, I assert, as the result of examining numbers of specimens, that, though in certain cases the new structure is dominant, a practiced eye seldom fails to detect traces of the older foliation, while in a large number of instances it is still as definite as the stripe in a slate. We have got, then, thus far—that pressure acting on rocks previously crystallized can produce a foliation; but when it has acted in Palæozoic or later times, the resulting structures can be identified, and these, as a rule, are distinguishable from those of the most ancient foliated rocks, while at present we have found no proof that pressure alone can produce any conspicuous mineral banding. I am aware that this statement will be disputed, but I venture to state, as one excuse for my temerity, that probably few persons in Great Britain have seen more of crystalline rocks, both in the field and with the microscope, than myself. So, while I do not deny the possibility of a well-banded rock being due to pressure alone, I unhesitatingly affirm that this at present is a mere hypothesis—a hypothesis, moreover, which is attended by some serious difficulties. For, if we concede that, in the case of many rocks originally granular, dynamic metamorphism has produced a mineral banding, this is only on a very small scale; the layers are but a small fraction of an inch thick. No one could for a moment confuse a sheared granite from the Highlands with a Laurentian gneiss from Canada or with an uninjured Hebridean gneiss. For the former to attain to the condition of the latter, the mass must have been brought to a condition which admitted of great freedom of motion among the particles—almost as much, in short, as among those of a molten rock. Clearly the dynamic metamorphism of Palæozoic or later ages appears to require some supplementary agency. Can we obtain any clew to it? I have already mentioned the effect produced by the intrusion of large masses of igneous rocks upon other rocks. These may be either igneous rocks already solidified or sedimentary rocks. The former may be passed over, as they will not materially help us. In regard to the latter, the results of contact-metamorphism, as it is called, as we might expect, are very various. Speaking only of the more extreme, we find that sandstones are converted into quartzites; limestones become coarsely crystalline, all traces of organisms disappearing and crystalline silicates being formed. In clayey rocks all signs of the original sediments disappear, crystalline silicates are formed, such as mica (especially brown) garnet, andalusite, and sometimes tourmaline; feldspar, however, is very rare. Fair-sized grains of quartz appear, either by enlargement of original granules or by independent crystallization of residual silica. It is, further, important to notice that, as we approach the surface of the intrusive mass—that is, as we enter upon the region where the highest temperature has been longest maintained—the secondary minerals attain a larger size and are more free from adventitious substances—that is, they have not been obliged, as they formed, to incorporate pre-existing constituents. The rock, indeed, has not been melted down, but it has attained a condition where a rather free molecular movement became possible, and a new mineral in crystallizing could, as it were, elbow out of the way the more refractory particles. Its effects are, in brief, to consolidate the rock, and, while causing some constituents to vanish, to increase greatly the size of all the others. It follows, then, that mineral segregation is promoted by the maintenance for some time of a high temperature, which is almost a truism. I may add to this that, though rocks modified by contact-metamorphism differ from the Archæan schists, we find in them the best imitations of stratification-foliation, and of other structures characteristic of the latter. One other group of facts requires notice before we proceed to draw our inferences from the preceding. Very commonly, when a stratified mass rests upon considerably older rocks, the lower part of the former is full of fragments of the latter. Let us restrict ourselves to basement beds of the Cambrian and Ordovician—the first two chapters in the stone-book of life. What can we learn from the material of its pages? They tell us that granitoid rocks, crystalline schists of various kinds, as well as quartzites and phyllites, then abounded in the world. The Torridon sandstone of Scotland proves that much of the subjacent Hebridean had even then acquired its present characteristics. The Cambrian rocks of North and South Wales repeat the story, notably near Llynfaelog in Anglesey, where the adjacent gneissoid rocks from where the pebbles were derived, even if once true granites, had assumed their present differences before the end of the Cambrian. By the same time similar changes had affected the crystalline rocks of the Malverns and parts of Shropshire. It would be easy to quote other instances, but these may suffice. I will only add that the frequent abundance of slightly altered rocks in these conglomerates and grits seems significant. Such rocks seem to have been more widely distributed—less local—than they have been in later periods. Another curious piece of evidence points the same way. In North America, as is well known, there is a great group of rocks to which Sir W. Logan gave the name of Huronian, because it was most typically developed in the vicinity of Lake Huron. Gradually great confusion arose as to what this term really designated. But now, thanks to our fellow-workers on the other side of the Atlantic, the fogs, generated in the laboratory, are being dispelled by the light of microscopic research and the fresh air of the field. We now know that the Huronian group in no case consists of very highly altered rocks, though some of its members are rather more changed than is usual with the British Cambrians, than which they are supposed to be slightly older. Conglomerates are not rare in the Huronian. Some of these consist of granitoid fragments in a quartzose matrix. We can not doubt that the rock was once a pebbly sandstone. Still, the matrix, when examined with the microscope, differs from any Palæozoic sandstone or quartzite that I have yet seen. Among grains of quartz and feldspar are scattered numerous flakes of mica, brown or white. The form of these is so regular that I conclude they have been developed, or at least completed, *in situ*. Moreover, the quartz and the feldspar no longer retain the distinctly fragmental character usual in a Palæozoic grit, but appear to have received secondary enlargement. A rock of fragmental origin to some extent has simulated or reverted to a truly crystalline structure. In regard to the larger fragments we can affirm that they were once granitoid rock, but in them also we note incipient changes, such as the development of quartz and mica from feldspar (without any indication of pressure), and there is reason to think that these changes were anterior to the formation of the pebbles. To sum up the evidence: In the oldest gneissoid rocks we find structures different from those of granite, but bearing some resemblance to, though on a larger scale than, the structures of vein-granites or the surfaces of larger masses when intrusive in sedimentary deposits. We find that pressure alone does not produce structures like these in crystalline rocks, and that when it gives rise to mineral banding this is only on a comparatively minute scale. We find that pressures acting upon ordinary sediments in Palæozoic or later times do not produce more than colorable imitations of crystalline schists. We find that when they act upon the latter the result differs, and is generally distinguishable from stratification-foliation. We see that elevation of temperature obviously facilitates changes and promotes coarseness of structure. We see also that the rocks in a crystalline series which appear to occupy the highest position seem to be the least metamorphosed, and present the strongest resemblance to stratified rocks. Lastly, we see that mineral change appears to have taken place more readily in the later Archæan times than it ever did afterward. It seems, then, a legitimate induction that in Archæan times conditions favorable to mineral change and molecular movement—in short, to metamorphism—were general, which in later ages have become rare and local, so that, as a rule, these gneisses and schists represent the foundation-stones of the earth's crust. On the other side, what evidence can be offered? In the first place, any number of vague or rash assertions. So many of these have already come to an untimely end, and I have spent so much time and money in attending their executions, that I do not mean to trouble about another till its advocates express themselves willing to let the question stand or fall on that issue. To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age respectively, as that the pre-Tertiary volcanic rocks should be altogether different in character from those of Tertiary and recent times. During the periods mentioned volcanic rocks appear, as we should expect, to have been ejected from beneath the earth's crust similar in composition and condition, and to have solidified with identical environment. Hence the results, allowing for secondary changes, should still be similar. But to assume that the environment of a rock in early Archæan times was identical with that of similar material at a much later period is to beg the whole question. My creed also is the uniformitarian, but this does not bind me to follow a formula into a position which is untenable. "The weakness and the logical defect of uniformitarianism" (these are Prof. Huxley's words) "is a refusal, or at least a reluctance, to look beyond the 'present order of things,' and the being content for all time to regard the oldest fossiliferous rocks as the *ultima Thule* of our science." Now, speaking for myself, I see no evidence since the time of these rocks, as at present known, of any very material difference in the condition of things on the earth's surface. The relations of sea and land, the climate of regions, have been altered; but because I decline to revel in extemporized catastrophes, and because I believe that in nature order has prevailed and law has ruled, am I therefore to stop my inquiries where life is no longer found, and we seem approaching the first-fruits of the creative power? Because palæontology is perforce silent; because the geologist can only say, "I know no more," must I close my ear to those who would turn the light of other sciences upon the dark places of our own, and meet their reasoning with the exclamation, "This is not written in the book of uniformity"? To do this would be to imitate the silversmiths of old, and silence the teacher by the cry, "Great is Diana of the Ephesians!" What, then, does the physicist tell us was the initial condition of this globe? I will not go into the vexed question of geological time, though, as a geologist, I must say that we have reason to complain of Sir W. Thomson. Years ago he reduced our credit at the bank of time to a hundred million years. We grumbled, but submitted, and endeavored to diminish our drafts. Now he has suddenly put up the shutters, and declared a dividend of less than four shillings in the pound. I trust some aggrieved shareholder will prosecute the manager. While personally I see little hope of arriving at a chronological scale for the age of this earth, I do not believe in its eternity. What, then, does the physicist tell us must have been in the beginning? I pass to the *consistentior status* of Leibnitz, when the molten globe had crusted over, and its present history began. Rigid uniformitarian though you may be, you can not deny that, when the very surface of the ground was at a temperature of at least 1,000° Fahr., there was no rain, save of glowing ashes—no river, save of molten fire. Now is ending a long history with which the uniformitarian must not reckon—of a time when many compounds now existing were not dissolved but dissociated, for combination under that environment was impossible. Yet there was still law and still order—nay, the present law and order may be said even then to have had a potential existence; nevertheless, to the uniformitarian gnome, had such there been, every new combination of elements would have been a new shock to his faith, a new miracle in the earth's history. But at the times mentioned above, though oxygen and hydrogen could combine, water could not yet rest upon the ruddy crust of the globe. What does that mean? This, that assuming the water of the ocean equivalent to a spherical shell of the earth's radius and two miles thick, the very lava-stream would consolidate under a pressure of about 310 atmospheres, equivalent to nearly 4,000 feet of average rock. Let us pass on to a time, which, according to Sir W. Thomson, would rather quickly arrive, when the surface of the crust had cooled by radiation to its present temperature. Let us merely, for illustration, take a surface temperature of 50° F. (nearly that of London), and assume that the present rise of crust temperature is 1° F. for every fifty feet of descent, which is rather too rapid. If so, 212° F. is reached at 8,100 feet, and 250° F. at 10,000 feet. Though the latter temperature is far from high, yet we should expect that, under such a pressure, chemical changes would occur with much more facility than at the surface. But many Palæozoic, or even later rock-masses, can now be examined which at a former period of their history have been buried beneath at least 10,000 feet of sediment, yet the alteration of their constituents has been small; only the more unstable minerals have been somewhat modified, the more refractory are unaffected. But for a limited period after the *consistentior status,* the increase of crust temperature in descending would be far more rapid; when one twenty-fifth of the whole period from that epoch to the present had elapsed—and this is no inconsiderable fraction—the rate of increase would be one degree for every ten feet of descent. Suppose, for the sake of comparison, the surface temperature as before, the boiling-point of water would be reached at 1,620 feet, and at 10,000 feet, instead of a temperature of 250° F., we should have one of 1,050° F. But, at the latter temperature, many rock-masses would not be perfectly solid. According to Sorby, the steam cavities in the Ponza trachyte must have formed, and thus the rock have been still plastic at so low a temperature as 680° F. At this period, then, the end of the fourth year of the geological century, structural changes in igneous and chemical changes in sedimentary rocks must have taken place with greater facility than in any much later period in the world's history. Then a temperature of

2,000° F., sufficient to melt silver—more than sufficient to melt many lavas—would have been reached at a depth of about four miles. It would now be necessary to descend for at least forty miles in order to arrive at this zone. During the ninety-six years of the century it has been changing its position in the earth's crust, more slowly as time went on, from the one level to the other. There is another consideration. In very early times, as shown by Prof. Darwin and Mr. Davison, the zone in the earth's crust at which lateral thrust ceases and tension begins must have been situated much nearer to the surface than at present. If now, at the end of the century, it is at the depth of five miles, it was at the end of the fourth year at a depth of only one mile. Then, a mass of rock, ten thousand feet below the surface, would be nearly a mile deep in the zone of tension. Possibly this may explain the mineral banding of much of our older granitoid rock, already mentioned, and the coincidence of foliation with what appears to be stratification in the later Archæan schists, as well as the certainly common coincidence of microfoliation with bedding in the oldest indubitable sediments. Pressure, no doubt, has always been a most important factor in the metamorphism of rocks; but there is, I think, at present some danger in overestimating this, and representing a partial statement of truth as the whole truth. Geology, like many human beings, suffered from convulsions in its infancy; now, in its later years, I apprehend an attack of pressure on the brain. The first deposits on the solidified crust of the earth would obviously be igneous. As water condensed, denudation would begin, and stratified deposits, mechanical and chemical, become possible, in addition to detrital volcanic material. But at that time the crust itself, and even stratified deposits, would often be kept for a considerable period at a temperature similar to that afterward produced by the invasion of an intrusive mass. Thus, not only rocks of igneous origin (including volcanic ashes) would predominate in the lowest foundation-stones, but also secondary changes occur more readily, and even the sediments or precipitates should be greatly metamorphosed. Strains set up by a falling temperature would produce, in masses still plastic, banded structures, which, under the peculiar circumstances, might occur in rocks now coarsely crystalline. As time went on, true sediments would predominate over extravasated materials, and these would be less and less affected by chemical changes, and would more and more retain their original character. Thus, we should expect that as we retraced the earth's course through "the corridor of time," we should arrive at rocks which, though crystalline in structure, were evidently in great part sedimentary in origin, and should beyond them find rocks of more coarsely crystalline texture and more dubious character, which, however, probably were in part of a like origin; and should at last reach coarsely crystalline rocks, in which, while occasional sediments would be possible, the majority were originally igneous, though modified at a very early period of their history. This corresponds with what we find in nature, when we apply, cautiously and tentatively, the principles of interpretation which guide us in stratigraphical geology. I have stated as briefly as possible what I believe to be facts. I have endeavored to treat these in accordance with the principles of inductive reasoning. I have deliberately abstained from invoking the aid of "deluges of water, floods of fire, boiling oceans, caustic rains, or acid-laden atmospheres," not because I hold it impossible that these can have occurred, but because I think this epoch in the earth's history so remote and so unlike those which followed that it is wiser to pass it by for the present. But, unless we deny that any rocks formed anterior to or coeval with the first beginning of life on the globe can be preserved to the present time, or, at least, be capable of identification—an assumption which seems to me gratuitous and unphilosophical—then I do not see how we can avoid the conclusion to which we are led by a study of the foundation-stones of the earth's crust—namely, that these were formed under conditions and modified by environments which, during later geological epochs, must have been of very exceptional occurrence. If, then, this conclusion accords with the results at which students of chemistry and students of physics have independently arrived, I do not think that we are justified in refusing to accept them because they lack the attractive brilliancy of this or that hypothesis, or do not accord with the words in which a principle, sound in its essence, has been formulated. It is true in science, as in a yet more sacred thing, that "the letter killeth, the spirit giveth life."

NATURAL SCIENCE IN ELEMENTARY SCHOOLS.*

By J. M. ARMS.

THE question before the educators of our country is a practical one, involving important and far-reaching results. Shall science lessons be given in elementary schools? It is a question which can be answered affirmatively or negatively only by considering *why* and *how* such lessons shall be given. What I have to say on the subject will be more practical than theoretical, as whatever views I hold are based wholly upon ten years' experience in teaching natural science to young people from five to twenty years of age. This being the case, my remarks must be necessarily more personal than I would wish.

* Read at the "National School of Methods," Saratoga, August, 1888.

Beginning to teach with no preconceived notions as to the practical results obtainable, but with a love for the science of Nature, and a strong desire to make our boys and girls love it also, I soon found out that science lessons were not only helpful in the way of awakening interest, but also invaluable in the way of disciplining the mind. Little children came to me with untrained eyes, hands, and brains; this I expected, and therefore was not surprised; but boys and girls from fifteen to twenty years of age came in a worse condition, and this was unexpected. Not only were their eyes and hands untrained, but their brains were in a pathological condition which rendered independent thinking impossible. The number of my pupils increasing, and their ages ranging, as I have said, from five to twenty years, I had an excellent opportunity for comparing the quality of work done by older and younger pupils, also by pupils whose perceptive faculties had been trained in early life, and those who had not received this training. The inferences I was forced to draw from these comparisons set me to thinking seriously. The inaccuracy of the observational and manual work done by older pupils, the indefiniteness of expression, the lack of system, and the inability to do comparative and inferential work, were so many revelations of the true aims of science teaching. The absolute necessity for accuracy in every study and every department of work made *accuracy* the first object to be attained in every science lesson; the vagueness of the oral and written statement made *clear, concise expression* the second object. The want of method emphasized the need of *a simple, orderly grouping of the observations,* while the painful and fruitless attempts to make comparisons and draw inferences showed the necessity of cultivating *the power of generalizing from specific facts.*

The objects of elementary science work in this way became clear to me. As time passed, I was convinced that the first two aims might be realized with children of primary-school age; the last two, in greater or less degree, with scholars of grammar and high school age, *provided they had received the preparatory training of the primary school.* In attempting to realize these aims I strove to apply constantly the scientific or "natural method" of teaching, and, though applying it far from perfectly, I could see that in more skillful hands than my own its successful application would result in that which was most desirable, *the development of the child.*

Gradually the opinion grew and strengthened, till it has now become a conviction, that those children who have been trained by the "natural method," from five to thirteen years of age, do better work at thirteen than those who have not received this training do from fifteen to twenty years of age. Their work is better because it is marked by greater accuracy, greater ability in mechanical execution, and stronger power of reasoning. It proves, in brief, that the doers of it are active and creative rather than passive and imitative.

The recognition of the truth of these statements, of the importance of the objects to be accomplished, and of the value of studies which promote their accomplishment in a pre-eminent degree, answers the question, Why shall science lessons be given in elementary schools?

The question, How shall these lessons be given? is one which demands immediate and serious consideration. Uncertainty prevails in the minds of teachers, and confusion in the general mind, on this subject. Oral and language lessons are often mistaken for science lessons, although usually the three have distinctly different objects. Judging from the many courses of study I have been privileged to examine the past year, I conclude that the oral lesson, *as generally given*, aims to interest the young. Whatever common objects happen to be at hand are used for the purpose, and the success of the lesson depends largely upon the animation and versatility of the teacher and the receptivity of the class. In order to make this oral lesson a science lesson, the objects observed must be selected in a natural sequence; the teacher must be logical in questioning, whether or not she be graphic in description, while the pupils must be independent seekers for knowledge rather than active or passive receptacles of information. I do not say the oral lesson can not be a science lesson, but that oral lessons, as generally given, are not science lessons.

The language lesson aims at the use of good language, at correct grammatical construction, spelling, and punctuation. Clear, concise expression may be one object of the language lesson, but it must be remembered that this is not the first object of the science lesson.

The question, How shall science lessons be given? can best be answered by keeping constantly in mind the aims of science work. Whatever helps to realize these, helps to answer the question, as the ways and means must be adapted to the end in view.

In giving observation lessons upon plants, animals, and minerals, which, here let me say, are elementary science lessons as well as those that have received this name in our prescribed courses of study, three conditions must obtain: First, the children must be provided with specimens; second, the school must be under the control of the teacher; third, the lesson must be prepared by the teacher in the form of questions which lead step by step from the simple to the more difficult. It is evident, if the pupils are to be provided with specimens of animals, that only the smaller and simpler ones can be used, such as the star-fish, sea-urchin, or snail. In many of our schools the lessons on animals begin with the dog, cat, or bird. Ten years ago it was almost a necessity to begin in this way; it is not so to-day. I once began a course of lessons with these familiar but extremely complex animals, and noted the results with interest. Before the course was finished, I had given up practically the four objects I aimed to accomplish. I was so thoroughly convinced that the habit of accurate observation could not be acquired by children with one specimen in the hand of the teacher, or one picture hung upon the wall, that I never repeated the experiment. I regret now that I did not preserve some of the written work of this class, but it seemed so worthless, as compared with that done by children of the same age who had begun their lessons with the simpler animals, that I did not keep any of it for future reference. When the class numbers fifty or sixty children, those in the back part of the school-room can not see the bird or kitten distinctly, more or less disorder prevails, and disorder always causes the premature death of science work. If the children come to the desk to examine the specimen, time is lost in going to and from the seat, especially by those whose besetting weakness is laziness, while the moments for observation at the desk must be extremely brief. Close, accurate observation of a specimen in the hand of a child develops patience, and cultivates the habit of mental equilibrium or concentration of mind for twenty or thirty minutes, as may seem desirable, which is of incalculable value.

The second condition of successful science work, namely, a well-governed school, is obviously one condition for all successful school-work. The temptation to whisper and be disorderly, caused, possibly, at first by the use of specimens, will soon be overcome if the children understand that no science lesson can be given till order is preserved. The unruly members of the class are usually the first ones to yield, as these are generally more fond of nature than of books. Many instances could be given, proving most happily the invaluable aid given by science lessons to the teacher in the discipline of lawless children.

While the first two conditions depend for their realization upon both teacher and pupils, the third depends wholly upon the teacher. All preparation must be made *before*, not during the lesson. The questions must be so arranged that each lesson must be a natural growth, a development from the simple to the complex. This method of questioning is the peculiar characteristic of the true science lesson, distinguishing it from the commonly accepted oral and language lesson. Furthermore, each lesson should be related, so to speak, to the lessons that precede and follow it. It can not exist as an isolated thing, but must form an important part of one complete course.

The course on animals for primary schools, as given in our first lesson, begins with the star-fish, and takes up in succession the following subjects: The sea-urchin; the star-fish and sea-urchin compared; the earth-worm; a bivalve shell (*Cyprina*); clam-shell; oyster-shell; clam- and oyster-shell compared; living snail; snail-shell; miscellaneous shells, including pearly nautilus; simple classification of shells; lobster or crayfish; crab; lobster and crab compared; habits of crabs; locust; young living dragon-fly; beetle; butterfly; life-history of butterfly; moth and life-history; bees and their habits; insects in general.

This course covers twenty weeks, devoting two hours a week to the subject. In a general way it may be stated, though of course there is no inflexible rule in regard to time, that the first hour is given to the observation and drawing of the specimen, the first fifteen minutes of the second hour to a review of the observations already made, the following thirty minutes to a written description of the specimen, and the last fifteen minutes to a talk about the habits of the animal. If the habits are discussed before the written work is done, the results are not as good, for the reason that it is much easier for children to describe vaguely the habits of animals than to give accurate, concisely stated observations. In almost every case (excepting, perhaps, two or three animals repugnant to many children, as, for instance, the earth-worm and spider) the teacher will obtain the most satisfactory results by taking structure first and habits afterward. In the primary course no alcoholic specimens are used, but living animals when possible and dried specimens.

The course for grammar schools begins with the horny sponge, and includes the following subjects: Silica sponge (*Geodia*); horny and silica sponge (*Chalina*); sponges compared; a simple animal (*Hydra*); sea-anemone; coral animal (*Galaxea*); sea-anemone and coral animal compared; corals (*Madrepore, fan coral*); star-fish and sea-urchin compared; earth-worm and salt-water worm (*Nereis*) compared; clam- and oyster-shell compared; snail and pearly nautilus; habits of salt- and fresh-water mollusks; lobster or crayfish; crab and barnacle; lobster; crab and barnacle compared; spiders; habits of spiders; locust and larva; dragon-fly and larva; locust and dragon-fly compared; squash-bug and larva; review insects with direct or "incomplete" metamorphosis; butterfly and caterpillar; beetle and grub; fly and maggot; bees; simple classification of insects.

In this course dried, alcoholic, and living specimens are used. The course may be given in twenty weeks, or forty hours, provided the children have gone through the primary course; otherwise, it can not be given, as good comparative work can only be done after accurate observational and descriptive work.

These two elementary courses lay a strong foundation for the high-school course, and also pave the way to the intelligent study of vertebrate life, while the three courses—primary, grammar, and high—furnish a valuable preparation for the advanced biological studies of our scientific schools and colleges. There has been much discussion in our leading journals of late in regard to the teaching of biology in the higher institutions of learning. What to teach and how to teach it have been pressing questions. Courses of study have been proposed which certainly have been ideal for ideal students, but which have almost wholly overlooked the important fact that the majority of the young men and women who are to take these courses have never learned the A, B, C of science work. Many professors, dissatisfied with the poor results obtained, have recognized the chief cause, and asserted that "the college instructor must still regard the student who studies under him as a school-boy whose capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school." * In other words, the college is forced to do preparatory work. This the college ought never to do. Preparatory work belongs to preparatory schools. A young man or woman at eighteen ought to be fitted to enter upon an industrial career or upon a scientific or classical course of study, as individual taste or necessity dictates, with hands trained to do a little manual work well, with eyes keen-sighted enough to see things as they are, and with brains capable of thinking upon these things independently.

I have outlined in brief a primary and grammar-school course upon animals. I have been aided in the preparation of these courses by the "Guides for Science Teaching," Nos. III–VII, by Prof. Alpheus Hyatt. Prof. Crosby's "Science Guide," No. XII, and Mrs. Richards's "Guide," No. XIII, are admirable aids in preparing a course upon our common minerals and rocks. The "Science Guide," No. II, by Prof. Goodale, and the well-known works of Prof. Gray, help in adapting the subject of botany to young minds. The present paper is considering the natural rather than the physical sciences, as these "are now generally acknowledged to afford the best means of developing the powers of observation and comparison."

It is impossible to discuss broadly and justly the questions why and how shall science lessons be given in elementary schools without some knowledge of the history of the movement which has given birth to these questions, and also some knowledge of the present status of our schools on the general subject of science teaching. The movement of which we speak the coming century will surely regard as one of the really great movements of our

* See "American Naturalist," June, 1887.

time, so that we may pause here to sketch briefly its origin and growth. After an extended correspondence with superintendents and educators of New England and the West, I may state, with very great certainty, that Boston was the first large city in our country to include systematic lessons upon plants, animals, and minerals in its prescribed course of elementary instruction. This was done in 1877–'78. The movement, however, may be said to have had its origin in the lecture-hall of Louis Agassiz nearly a quarter of a century before. Recognizing the educational and practical value of the study of natural history, and imbued with a broad, humanitarian spirit, Prof. Agassiz invited teachers to attend his lectures before the under-graduates of Harvard. Among those who accepted this invitation was a young woman of whom George B. Emerson wrote, a few years later, "She is the best teacher New England has produced." The truths spoken by the great naturalist *lived* in the brain and heart of Lucretia Crocker till she in her turn was able to inspire the youth of her generation with a love for nature as deep as it was strong. Twenty-five years after the Harvard lectures, Miss Crocker, as supervisor of the public schools of Boston, with the keen judgment of mature womanhood added to the enthusiasm of youth, was advocating with persuasive power a course of elementary instruction which included lessons upon our common plants, animals, and minerals. In 1877–'78 this course was adopted by the school board, and Miss Crocker became supervisor of the natural history work. Surely the inspired words of Agassiz were bearing abundant fruit, though the voice that uttered them was then silent. May we not trust that the harvest-time was known to the sower of the seed?

It soon became evident that the teachers wanted more knowledge of the natural history subjects which they were to teach; and it was then that Miss Crocker found an able helper in Prof. Alpheus Hyatt, who, in the generous spirit of his teacher, Prof. Agassiz, threw the doors of his laboratory wide open to all who wished to come. A "Saturday morning class" was formed. Its members were provided abundantly with specimens for study, and the valuable collections of the Natural History Museum, of which Prof. Hyatt was curator, were freely used in the demonstrations.

The teachers, now as pupils, saw more clearly than ever before the true objects of all science work, namely, the betterment of humanity and the increase of our stock of absolute knowledge. Fortunate indeed are those institutions of learning which number among their professors one who keeps constantly before his pupils these high ideal aims of science! With these aims as ultimate goals, the work of student and teacher becomes more effective, because directed in definite yet ever-broadening channels.

An organization, known throughout New England as the "Teachers' School of Science," had been carried on since 1871 by the liberality of one person, Mr. John Cummings, a patron of the Society of Natural History. The faith of Mr. Cummings in the educational value of nature lessons was constant, as proved by his generous contributions year after year.

In the winter of 1878–'79 the pecuniary responsibility of the "school" was assumed by two Boston ladies, Mrs. Pauline Agassiz Shaw, the daughter of Prof. Agassiz, and Mrs. Augustus Hemenway. Five hundred teachers attended this course of lessons upon the scientific method of teaching applied to the study of our common plants, animals, and minerals. Nearly a hundred thousand specimens were carried into the public schools, and the publication of the series of "Science Guides," to which we have referred, was begun, to aid teachers in their work. A new impetus was given to the movement, and an enthusiasm created which promised much for the future.

Eleven years have passed since nature lessons were embodied in the prescribed elementary course of the Boston schools. What is the position of these and other schools of our country on this subject? Do the leaders of the movement who are living to-day feel a sense of disappointment that the results have not been larger? The growth, it is true, has been slow; yet if those who are oppressed by the truth of this statement would compare the science work done in the schools to-day with that done ten or twenty years ago, they would surely bend to their oars with new courage. That work can be briefly described: the quantity was extremely small, and the quality exceedingly poor.

We are beginning to recognize the fact that science lessons can not exert their legitimate influence so long as they are not included in the prescribed curriculum of study, but depend for their life upon the option of the teacher. I have endeavored to obtain exact information on this subject. In New England there are eighty-seven cities and towns whose schools are provided with a superintendent.* Of these, eight include lessons on plants, animals, or minerals in their prescribed courses of study, under the head of "Observation and Elementary Science Lessons," or of "Plants, Animals, Minerals." Fifteen include such lessons under the head of "Oral Instruction." Eleven take up natural objects in connection with language and geography lessons. Five are revising their courses of study, three of which are including observation lessons. Four have not replied to my letter of inquiry. This leaves forty-four cities and towns whose elementary courses do not include nature lessons.

Personal interviews and correspondence with educators in

* See "List of the School Superintendents," for June, 1888.

many Western and Southern States leads me to say, with considerable certainty, that in none of their primary and grammar schools are science lessons *required.*

These facts and figures represent the work prescribed, not the work actually done. In how many schools where these lessons are required are they given by the scientific method ? is a question of the first importance. In how many schools, on the other hand, where the lessons are not required are they systematically given by progressive teachers ? Want of sufficient data compels me to leave these questions unanswered for the present.

The picture has another and somewhat brighter side. It may be stated as an indisputable fact that there never has been a time when the interest in the subject was so wide-spread. Educators all over the country are giving it their thoughtful consideration. The "National School of Methods" has offered an excellent opportunity for the past three years for obtaining valuable information. Twenty-one States,* and probably several more, have been represented in the natural history classes.

Teachers of primary, grammar, high, and normal schools have testified to the educational value of nature lessons. Superintendents have expressed their approval of such lessons, and shown an earnest desire to help forward the work. This hearty interest, especially on the part of normal-school teachers, is a guarantee that the growth of the movement will continue to be sure, even though it may be slow. This brings me, in conclusion, to the brief consideration of the causes of this slow growth.

The fundamental cause lies, I believe, in our ignorance of the true value and large possibilities of elementary science work. This ignorance is chargeable in great measure to that one-sided system of education which has long prevailed. Our early training, in fact, unfits us for justly appreciating the objects to be attained. If the great body of teachers in our country to-day could be made to know the full value of natural history lessons in the mental training of the young, I for one do not believe the oft-repeated arguments against this kind of teaching would deter them in the least from undertaking the work. Our primary-school teachers need to know for their own inspiration how much they are helping the grammar-school teachers, and the grammar-school teachers, in their turn, the high-school teachers. When they come into possession of this knowledge, the movement will advance with rapid strides, and the four arguments oftenest urged will be answered by the teachers themselves.

When it is said, "The work is impracticable, because specimens

* Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Virginia, North and South Carolina, Alabama, Kentucky, Louisiana, Indiana, Illinois, Iowa, Wisconsin, Michigan, Minnesota, and Nebraska.

can not be obtained," the teachers will reply: "Several towns have already appropriated ten and twenty dollars for the purchase of natural history collections, and these can be used a number of years. Teachers awakened to the new and beautiful revelations of nature are preserving specimens at the sea-shore and in the country. Children have collected hundreds of specimens which have been used in class work, or have helped to form valuable school cabinets."

When, again, it is said, "Our teachers have not been trained by the 'natural method'; how, then, can you expect them to teach by it?" they will answer: "We know from experience the defects of the old methods; is it not possible, then, for us to shun these defects, and to teach by better, more effective methods? The fossilization of teachers is not in order. We must grow, for growth is the necessity, if not the charm, of the teacher's life of to-day."

Again, when it is said, "Too much observational work results in lack of mental concentration and in weak power of memorizing," they will assert: "The time for considering the results of 'too much observational work' has not yet come, nor is the danger so imminent as to concern us now. The criticism offered may be true of much poor oral instruction which 'entertains' children, but it can not be true of elementary science work, the very soul of which finds verbal expression in the words individual effort—such effort as is only possible when the mental faculties are under control."

It is true the mission of the science lesson is not to strengthen the memory. The studies of literature and language do this, while the science lesson quickens the perceptive faculties and cultivates the power of delicate discrimination and of just generalization.

Finally, when it is urged that "the object of this teaching is to make naturalists of our children," they will emphasize the fact that while the object of advanced biological teaching may be to make specialists of those who have an aptitude for this work, the object of *elementary* science work must be, always and ever, the training of the young mind. We are just beginning to find out that a one-sided system of education is not sufficient for our many-sided human nature. We are not all born to be teachers, or professors of law or medicine; we have among us natural mechanics, merchants, inventors, investigators; and a system of instruction which is not broad enough to train these for a life of productive industry falls far short of what it ought to do. Education must have its industrial and scientific as well as its classical side, and not until it does will each child realize its own bright possibility of a better and more enlightened humanity.

THE ARYANS IN SCIENCE AND HISTORY.

By HORATIO HALE.

FROM the Bay of Bengal westward, through northern India, Afghanistan, Beloochistan, Persia, Armenia, Asia Minor, and on through Europe to its farthest bounds—and thence, in modern times, crossing the Atlantic and spreading over both Americas—one great linguistic family occupies a vaster space, peopled by a larger number of famous and powerful nations, than belong to any other ethnic kindred. But this pre-eminence of the Indo-European stock has not always existed. There was a period in the early history of the civilized world when the Hamito-Semitic family was more widely diffused than any other; and at a later time, when the Arabian empire stretched from India to Spain, this preponderance seemed to be restored. Even in our day the Chinese language and literature are probably spoken and read by a larger population than is claimed by any other race. But there can be no question that during the last two centuries the communities speaking languages of the first-named family, or at least some among them, have been the dominant nations of the globe.

In the brief term of less than a century which has elapsed since the connections and limits of this great family have been ascertained, various designations have been applied to it—Indo-European, Indo-Germanic, Indo-Celtic, Aryan. The latter name, being the least cumbrous, is gradually gaining acceptance, even among those who dissent from the inference which its use might seem to imply. The term "Aryan" properly belongs to the easternmost group of these languages, comprising the tongues of ancient Persia and northern India. But scholars like Penka, Poesche, Sayce, Taylor, and others, who contest the Asiatic origin of the Aryan race, are still willing to accept its Asiatic name.

When it was first discovered that most European nations spoke languages of the Aryan (or Indo-Persian) stock, the conclusion was at once drawn that these European Aryans must look for their ancestral home in the East. As no one doubted that all the nations of this stock had sprung from one source, it was natural to inquire in what place the primitive Aryan tribe had its original seat. It was natural also to adopt the view that this seat was to be found somewhere in that portion of central Asia to which the traditions embodied, however vaguely, in the earliest known compositions of Aryan origin, the Vedas and the Zend-Avesta, seemed to point. This region, which comprehends ancient Persia and Bactria, has, from the earliest times of which we have any knowledge, been the home of Aryan communities. The reasons for accepting it as the peculiar seat of the race seemed conclusive to ethnologists until a very recent date. Of late years some scholars of high rank, both in Germany and in England, have been led to adopt the suggestion, first made by the late eminent English philologist, Dr. Latham, that the Aryans may have been of European origin. Their arguments were well summed up in the interesting address delivered last year before the Section of Anthropology in the British Association by the president of the section, Prof. Sayce. They have since been fully considered and discussed by Prof. Max Müller in his recent work, "Biographies of Words, and the Home of the Aryans." His decision is that to which the great majority of ethnologists have long since given their assent, namely, that the preponderant weight of argument points to an Asiatic home for the race. Some of the grounds for this conclusion will presently be shown; but, in the first instance, it becomes necessary to fix the locality of this primitive seat somewhat more definitely than it is placed in Prof. Max Müller's essay. He finds that the Aryan home must have been "somewhere in Asia," but declines to say more.

This conclusion, it is evident, is too indefinite for science; nor does it seem likely that the learned author, if he had cared to be more precise, would have had any difficulty in drawing a much narrower limit. The "method of elimination" is easily sufficient for this end. From the whole of Asia we strike out at once, by the common consent of ethnologists, its eastern third, comprising China, Japan, and Thibet, and along with it, by like consent, the three great southern peninsulas, the Indo-Chinese, the Indian, and the Arabian. With Arabia the rest of the ancient Semitic countries, Mesopotamia, Syria, and Phœnicia, will be erased from the problem. The immense expanse of Siberia will also disappear; for, though one bold speculator has sought a frigid home for the early Aryans in that region, he has, as might be supposed, gained no adherents to his theory. No one proposes Asia Minor; and Armenia and the Caucasus seem put out of the question by the fact that our earliest historical knowledge of those regions shows them inhabited mainly by non-Aryan tribes.

The limits of the pristine Aryan home are thus readily and inevitably narrowed down to those already suggested—the bounds of ancient Persia and Bactria—that "vast plateau of Iran," as Archdeacon Farrar has well styled it, in which the mother-tongue of the Sanskrit and Zend was once spoken by the united community, from whose divided septs the Vedas and the Zend-Avesta have been bequeathed to us. In that region, as we have every reason to believe, the Aryan race was found in its purest condition. When, therefore, we seek to ascertain the physical and mental traits which properly belong to this remarkable race, we naturally turn our attention to that Medo-Persian people, in whom the character of the unmixed stock was first distinctly manifested. The results of such an inquiry may yield some valuable fruits to ethnological science.

But before proceeding with this branch of our study it will be necessary, if our search for the origin of the Aryan race is to be conducted on strictly scientific lines and to be carried back to the very germ of the race, to bear in mind the self-evident truth that every linguistic stock must have originated in a single household. Somewhere on earth there must have been an "Aryan family-pair," the progenitors of the breed; and all the speakers of the primitive Aryan tongue must once have been gathered, as has been well said, "under one roof." In an address which I had the honor of delivering before this section * two years ago, I endeavored to point out the conditions under which such a household must have been formed, and to show that it must necessarily have originated in some isolated spot where a little brood or a pair of orphan children, left alone at too early an age to have a completed language, could have found the means of subsistence. This must have been in some region where severe frost is unknown, and where food could readily be obtained by very young children all the year round. No such spot can be found in Europe, a fact which would make the rise of a new linguistic stock in that quarter of the globe, under its present climatic conditions, difficult to comprehend. But in the Aryan territory already described such a district presents itself at once in the semi-tropical belt which borders the Persian Gulf and the Indian Ocean, and is known in modern geography as the Deshtistan, or "low country," of the province of Fars—that province which has always been deemed the original seat of the Persian people. In this coast district, as we are told by Prof. Rawlinson, snow never falls and there is but little rain. Heavy dews, however, occur at night, so that the mornings are often fresh and cool. Most of the region is dry and barren; but along the streams there is moisture, and the fruits of the tropics thrive. The sandy shore abounds in shell-fish and especially in oysters. On the northern coast of the Mexican Gulf, where the climate and other conditions are somewhat similar to those of this Aryan belt, I have seen from my open window in midwinter, while the magnolias were blooming near and the orange-trees showed their belated fruit, the little children of five or six years old wading at low tide in the shallow water, feeling with their naked feet for the shell-fish and gathering them into their baskets

* The present article was read before the Section of Anthropology, in the American Association for the Advancement of Science, at its meeting in August, 1888. The "Vice-Presidential address" referred to is published in the Proceedings of the Association for 1886.

for breakfast. As wild fruits and edible roots also abound along this coast, affording abundant nutriment at all seasons, it is not surprising that several peculiar linguistic stocks among the American languages appear to have originated in that genial region—just as others are found under similar conditions along the coast of California. There is, therefore, nothing improbable in the supposition that the first Aryan family—the orphan children, perhaps, of Semitic or Accadian fugitives from Arabia or Mesopotamia—grew up and framed their new language on the southern seaboard of Persia. As the number of their descendants increased, they would naturally spread northward over the province of Fars, and thence into the wide regions bounded by the Tigris, the Indus, and the Oxus, which we have recognized as the primitive seat of the Aryan power.

In pursuing our inquiry into the distinctive characteristics of this race it will not be necessary to resort to many authorities. All the important evidence has been carefully brought together by Prof. Rawlinson in his well-known work, "The Seven Great Monarchies of the Ancient Eastern World." His lucid summaries are fortified by numerous references, and his conclusions are confirmed in the main by every writer who has treated on the subject. As regards the physical traits of the race, he presents us (in the third chapter of his history of the "Median Empire") with a picture which, according to our ideas, is highly prepossessing. "The general physical character of the ancient Aryan race," he observes, "is best gathered from the sculptures of the Achæmenian kings, which exhibit to us a very noble variety of the human species—a form tall, graceful, and stately; a physiognomy handsome and pleasing, often somewhat resembling the Greek; the forehead high and straight; the nose nearly in the same line, long and well formed, sometimes markedly aquiline; the upper lip short, commonly shaded by a mustache; the chin rounded and generally covered with a curly beard. The hair evidently grew in great plenty, and the race was proud of it." The color of the skin can not be determined from this source; but from other authorities and from the descriptions of ancient travelers we learn that it varied, and still varies, much as in central and southern Europe, from a fair and almost blond hue, with blue or gray eyes, in the northern highlands, to a clear brunette in central Persia, and an almost negro swarthiness along the torrid shores of the Persian Gulf. The Aryan complexion yields readily to climatic influences, and those who think they find the primitive type of the race solely in that small fraction of it which offers us fair skins, blue eyes, and flaxen hair, assuredly fail to observe in anthropology the rules of evidence which govern inquiries in every other branch of science.

Of the moral qualities of the race, the account given by the historian—whom no one will suspect of hostile prejudice—is not altogether so favorable. "Among their moral characteristics," he tells us, "the one most obvious is their bravery"—which (we are elsewhere told) was combined with a remarkable and persistent energy. "But this valor," he adds, "was of the merciless kind." Not only did their armies (in Scriptural phrase) "dash to pieces" the fighting men of the nations opposed to them, allowing apparently no quarter, but the women and children suffered indignities and cruelties at the hands of the savage warriors which the pen unwillingly records. "Spoil, it would seem, was disregarded in comparison with insult and vengeance; and the brutal soldiery cared little for silver or gold, provided they could indulge freely in that thirst for blood which man shares with the hyena and the tiger." This inclination to cruelty, as he shows more fully in his subsequent account of the Persians, was a marked characteristic of the race. Their ordinary punishments were of the most barbarous nature. They were not content with merely putting their criminals or enemies to death, but sought out ingeniously the methods of execution that would cause the most protracted torture. Crucifixion, impalement, flaying alive, and the terrible infliction of "the boat," described with revolting minuteness by Plutarch in his life of Artaxerxes, were common methods. Scourging and mutilation—the lopping of hands and feet, the tearing out of eyes—were the usual "secondary punishments."

This propensity to cruelty seems to be, in a certain way, connected with another governing trait of the Aryan character—a trait which, at first thought, might appear to be not merely alien but opposed to that propensity. This trait may be described as a constant and overwhelming sense of reverence. When we peruse the earliest known compositions of this race, the Vedas and the Avesta, and compare them with the Hebrew Scriptures and the poems of Homer and Hesiod, we observe one striking difference. With the Hebrews and Greeks religion was much, but their own people, their national history, their laws and institutions, their homes and their families, had a large place in their thoughts. With the early Aryans, of the unmixed race, their gods were all in all. Everything else, in comparison, was too insignificant to be dwelt upon for a moment. In this great mass of their primitive literature we find not a word relating to their history, except the merest hints, thrown out incidentally and, in a manner, unconsciously. With them man and his interests were as nothing. Why should not this worthless being, if he became offensive, be treated like a noxious insect or poisonous reptile—be crushed, impaled, flayed, or buried alive? Thus we may see how, with this naturally bloodthirsty people, religion, which in other minds has led to the extreme of charity and self-sacrifice, might be combined with the worst exhibitions of cruelty.

This same overpowering sense of reverence, directed toward their earthly rulers, became an excessive servility, which made the Aryans incapable of freedom. On this important point the exact expressions of the historian deserve to be cited. "The feeling of the Persian toward his king," he tells us, "is one of which moderns can with difficulty form a conception. In Persia the monarch was so much the state that patriotism itself was, as it were, swallowed up in loyalty; and an absolute, unquestioning submission, not only to the deliberate will but to the merest caprice of the sovereign, was, by habit and education, so ingrained into the nature of the people that a contrary spirit scarcely ever manifested itself. In war the safety of the sovereign was the first thought and the principal care of all. . . . Uncomplaining acquiescence in all the decisions of the monarch—cheerful submission to his will, whatever it might chance to be—characterized the conduct of the Persians in time of peace. . . . The father, whose innocent son was shot before his eyes by the king in pure wantonness, instead of raising an indignant protest against the crime, felicitated him on the excellence of his archery. Unfortunates, bastinadoed by the royal order, declared themselves delighted because his majesty had condescended to recollect them. A tone of sycophancy and servility was thus engendered, which, sapping self-respect, tended fatally to lower and corrupt the entire character of the people."

He who is servile to his rulers is usually tyrannical toward his inferiors. We learn from the Greek historians what the government of the Persian monarch and his satraps was in their day, and modern travelers find that the lapse of twenty-five centuries has made no change in this respect, and little in any other. So far as history gives us information, no self-governing community has ever been found among any purely Aryan people.

One fine trait, however, which the ancient authors ascribe to the Persians should be recorded to their honor—their truthfulness. According to Herodotus, every young Persian was taught by his preceptors three main things—"to ride, to draw the bow, and to speak the truth. . . . In the Zend-Avesta, and more especially in its earliest and purest portions," continues Prof. Rawlinson, "truth is strenuously inculcated. Ahura-Mazda himself is 'true,' 'the father of all truth,' and his worshipers are bound to conform themselves to his image." This quality of truthfulness is not commonly deemed to be consistent with servility; but we must remember that the servility of the Aryans was the fruit, not of the timidity of conquered serfs, but of the reverence of brave men for their earthly deities. The Turk, who bows implicitly to the vicegerent of Allah, is too proud to lie.

In intellectual capacity the people of the Iranic plateau held but a low rank, not only in comparison with their Semitic neighbors, but absolutely as a race. They had, indeed, or rather one profound thinker among them had, excogitated a religious system—the Zoroastrian—which is held to be of a cast considerably superior to the religions of the neighboring nations; but in all other respects their inferiority was marked. Of the Semitic Babylonians the historian observes that, "among the moral and mental characteristics of the people the first place is due to their intellectual ability. . . . Their wisdom and learning are celebrated by the Jewish prophets, Isaiah, Jeremiah, and Daniel. The Father of History records their valuable inventions; and Aristotle was not ashamed to be beholden to them for scientific data. They were good observers of astronomical phenomena, careful recorders of such observations, and mathematicians of no small repute." Of the Persians, on the other hand, he remarks that "we can not justly ascribe to them any high degree of intellectual excellence." The remains of their architecture and sculpture which have come down to us display, he considers, a comparatively inferior artistic ability; and "to science," he declares, "they had contributed absolutely nothing." It is deserving of note that not one of the great inventions and discoveries which have promoted the progress and welfare of the human race seems to have been of Aryan origin. For the alphabet, the smelting of metals, the making of glass, ship-building, the mariner's compass, the methods of agriculture and of textile manufactures, the laws of geometry and astronomy, the world has been indebted to other races. We might be inclined to ascribe the backwardness of the Aryans in these respects to the disadvantages of their situation; but we notice that they seem as a race incapable of appreciating and adopting the gains of other intellects. At the present day travelers find the Persians the least advanced of the Oriental races. They are behind even the Turks, and are far below the Chinese and the Japanese. They are now, as of old, a brave, handsome, and showy race, prepossessing and courtly, but are still shamefully servile, vilely cruel, scornful of science, and fatally unprogressive.

It is a common opinion that the excellence of the Aryan language affords evidence of high intellectual capacity in its framers. That there is some warrant for this view may be admitted; but it must be remembered that the opinion arose while the science of comparative philology was in its infancy. The wider linguistic knowledge of our times shows it to have been a greatly exaggerated estimate, the product to a large extent of mere ignorance and the conceit of race. Capacity for expression is the main test of the excellence of a language; and, though the Aryan speech undoubtedly ranks well in this quality, there are found to be many languages in America and in Africa which decidedly surpass it. In certain other characteristics it is anything but admirable. Those who created and fashioned it seem to have been endowed with a peculiar linguistic talent or language-making faculty, which was not under the control of any logical force. What could be more absurd than the preposterous gender-system which the Sanskrit, the Greek, and the German have inherited from this Aryan mother-tongue, and from whose ridiculous trammels the speakers of all the later derived idioms in Asia and Europe have been for centuries striving to shake themselves free? The senseless superfluity of declensions and conjugations, the needless variety in the methods of forming the plural, the inordinate perplexity of the irregular verbs, are only a few of the evidences to be noted of the striking deficiency in logical and classifying power which, amid all their unquestioned excellences, the earlier Aryan languages everywhere betray.

But, it will naturally be asked, if the primitive Aryans were really a people of such moderate endowments, both in intellect and in morality, how do we explain the immense progress and the admitted headship and mastery among the nations of the world which their descendants have attained in Europe? The answer is ready at hand, and, indeed, almost self-evident. The people of Europe are of mixed race. They are Aryan exactly as the modern Peruvians are Spanish, or as the modern Egyptians are Arab. There is good reason to believe that primeval Europe was inhabited by tribes belonging to various races, differing considerably in character, but all of them distinguished by a love of freedom and a sentiment of personal independence. These traits caused the population to be broken up into numerous petty communities, each of which fell an easy prey to the Aryan invaders. The latter were not only, as we have seen, a race of remarkably brave and energetic warriors, but they had also the immense advantage, for an invading force, of a disposition which led them to render implicit obedience to their rulers. It is this trait of character which in Africa has often enabled the leader of a horde to establish his sway over a vast agglomeration of disconnected tribes. It is evident that in such a case, as in the case of the Turkish conquest of Asia Minor and eastern Europe, the subdued populations may be superior to their conquerors in every quality except in the capacity for combined effort.

The earlier inhabitants of Europe seem to have been of three distinct races—in the southeast Semitic, in the southwest Iberian, in the north and center Uralian. The Semitic tribes, which peopled Greece and probably a part of Italy and of the Mediterranean islands, belonged apparently to that branch which is variously styled Hamitic, Proto-Semitic, Libyan, and North African. Issuing probably from Asia in the earliest ages, it peopled Egypt and Barbary, and made its way even to the Canary Islands. That it spread northward at various points across the Mediterranean there can hardly be a doubt. Its purest modern representatives are the Berbers, the hardy mountaineers of the Atlas range, of features and complexion almost European, and in character possessing precisely the traits which the Aryans lacked. This character can not be better shown than by copying the concise description given by Dr. Topinard in his "Anthropology." Of the Berber, regarded as the type of this race, he says: "A lively sentiment of equality, of charity, of his own dignity and of his personal liberty, a great desire for activity, love of labor, economy, attachment to his home, are his moral characteristics." All these traits appear in those most famous members of the Proto-Semitic stock, the ancient Egyptians, and with them a love of science and art and a strong inclination for literary production. Such, apparently, were the people in Greece and the adjacent islands and coast-lands of the Mediterranean, on whom the Aryans imposed their government and language and certain traits of their character How large an element of the Hellenic people this aboriginal population contributed is shown by the language. In that, as in all mixed tongues, the grammar is mainly from one source; it is almost purely Aryan. But the vocabulary shows a large infusion of words which can not possibly have come from any other source than from a subject race thus conquered and absorbed. Prof. Sayce, in the address already referred to, informs us that "Mr. Wharton has found, by a careful analysis of the Greek lexicon, that out of twenty-seven hundred and forty primary words only fifteen hundred can be referred with any probability to an Indo-European origin." To what linguistic stock this non-Aryan element in the Greek language belonged is a question which remains for philologists to determine; but every indication of locality and of physical type, of moral and mental traits, and of early Hellenic tradition embodied in the legends of Ægyptus, Danaus, and Cadmus, points to a Proto-Semitic origin. To this primitive race, whatever it may have been, were evidently due all the finer and nobler qualities of the Greek character and intellect. To their Aryan conquerors they owed, along with an increased comeliness and grace of shape and feature, their martial energy, their amenability to discipline, and doubtless certain barbarous usages, such as their custom of putting to death in cold blood their enemies taken in battle.

The Iberian race resembles the North African so closely in physical, mental, and moral traits that, but for the total difference between the Berber and the Basque languages, ethnologists would be inclined to class them together. The Iberians, however, perhaps from their more northern and rugged abode, seem to have been a sturdier race, and more stubborn in maintaining their independence or reasserting it after a defeat. They occupied apparently the Spanish Peninsula, the greater part of France, the British Islands, Corsica, Sardinia, and probably a large portion of Italy, where they seem to have been mingled with the Semitic Pelasgians. The Aryan conquest, which in their case was incomplete, made little change in their character, except in Italy. In the far west the Celts have always shown the genuine Iberian character—the strong family affections, the love of home, the cheerfulness under all troubles, the sense of personal and tribal independence, and the jealous impatience of arbitrary power. To these traits the Aryans added in Italy a stronger infusion than was perhaps found anywhere else of their warlike and disciplined energy, and of their tendency to barbarity in war and to the infliction of cruel punishments in time of peace.

When the Aryan invaders entered the northern and central portions of Europe, they found that region occupied by tribes of the Uralian or Finnish type. On this point, and on the general question of the early peopling of Europe, I may cite the opinion pronounced, after many years of study, by one of the most eminent anthropologists of Europe, whose conclusions will be admitted by all to be entitled to the greatest weight—M. de Quatrefages. Referring in one of his recent works—"*Hommes Fossiles et Hommes Sauvages*"—to the "Finnish group," he observes: "This group has for European ethnogeny a very great importance. We know to what hypotheses, to what discussions, it has given rise. Both have been often premature, because the facts that were needed to establish the conclusions were not yet discovered. The 'Finnish theory,' to use the expression of Latham, is certainly wrong when it regards the whole of Europe as having been inhabited, before the arrival of the Aryans, by a single race, extending from Gibraltar to the Arctic Ocean—a race of whose existence the Finns would be merely the evidence. It is in the right when it admits the existence of a pre-Aryan population. This is a fact which can not now be questioned. We may affirm, moreover, that this population was not homogeneous; that it numbered several very distinct races; that these races have not been annihilated; that they have borne an important part in the formation of the existing populations, and that, in certain cases at least, they constituted in them the preponderant element." It is, of course, highly satisfactory to find that the conclusions to which linguists have been led by philological data are thus fully confirmed by the minute and careful studies of the physical types of European races, ancient and modern, which have been pursued by this distinguished investigator for nearly half a century.

M. de Quatrefages proceeds to show the evidences of the former extension of the Finnish race through the countries now occupied by the Slavonic and Teutonic populations. Of one particular tribe his opinion will astonish those ethnologists who have held up this peculiar sept as the most primitive and typical remnant of the Aryan race. The Lithuanians, he finds, are in the main of Uralian origin. "Though they speak an Aryan idiom, they are nevertheless," he affirms, "not Aryan in blood. They are the brothers of the Esthonians, and if these are Finnish, as all the world agrees, the others are Finnish likewise."

Among the Finns he finds two distinct types. That which comprises the great majority of the people has a decidedly Mongol cast. The other inclines to the Aryan type. He has no doubt that among the so-called Finns and their congeners there has been a strong infusion of Aryan blood; and this admixture will sufficiently explain the traces of the Aryan language which many scholars, including Diefenbach, Weske, Cuno, and, lately, Canon Taylor, have pointed out in the Uralian dialects. The people of the proper Finnish type are of medium stature, sturdy and muscular, with large and square heads, long, broad, and square faces, the lower jaw strongly developed, the nose small and rather wide, the mouth large, the complexion fair, deepening to olive gray; the eyes small, sometimes slightly oblique, the iris a grayish blue or bluish gray; the hair flaxen in hue, or sometimes of a reddish yellow, straight and silky. In character they are serious, manly, thoughtful, taciturn, slow in movement, both physically and mentally; very conservative, disposed to live at peace with the authorities; somewhat suspicious and vindictive; patient and resolute under suffering; not demonstrative, but kind and helpful to their neighbors; and at bottom thoroughly honest and faithful.

In all these traits, both physical and moral, we see clearly the basis of the Slavonic type and, to a large extent, of the Teutonic; though here apparently there has been some admixture of another primitive element, probably the Iberian. Over all is impressed, and more especially, as might be expected, among the higher classes, the influence of the Aryan conquerors, who, to use the striking expression applied by the poet Campbell to the Normans in England, have "high-mettled the blood" of the race. Under this influence the Uralo-Aryan nations of northern and central Europe, while still patient, conservative, and long-enduring, have become capable of united action, of strenuous effort, and of a resulting progress in thought and freedom which the Aryans themselves, in their primitive seats, have never been able to compass.

Nothing is more certain than that the immense advance of the European Aryans (so styled) beyond those of Asia has been due mainly to the aboriginal races whom the Asiatic invaders overcame by virtue of their superior organization, but whose posterity still constitutes the main element in the population of Europe. The simple comparison of the Iranians, ancient and modern, with the nations of the West, affords ample evidence on this point. Of the ancient Persians we have had a vivid portraiture from Rawlinson. Their modern descendants are described to us by a late traveler, Mr. Arthur Arnold, an English gentleman of keen discernment and of much experience among Oriental races. In his recent work, "Through Persia by Caravan," he gives an account of the government and the people, which shows them both to be much as they were in the days of Xerxes. Of all governments above the grade of savagery, the Persian seems to be the worst; and all that can be said for it is that it faithfully reflects the character of its people. The ordinary punishments are still, as in former days, death and the bastinado; and each of these punishments is inflicted with the most ingenious refinement of cruelty. Shortly before Mr. Arnold's arrival, the governor of Fars had endeavored to repress crime in that province by a special exhibition of energy. "He tried," we are told, "throat-cutting, and left the bleeding bodies exposed to the view of all comers in the public square of Shiraz. He tried crucifixion, nailing the wretches by the hands and feet to the walls of the town, and leaving them under a guard of soldiers to die of exhaustion and starvation. Finally, he tried burial alive in pits, or cylinders of brick-work, of depth such as to allow the criminal's head to appear above the top;" in which condition, we are told, "the miserable men were in their dying hours barbarously ill-treated, on their exposed and defenseless heads, by the rabble and soldiery of Shiraz."

Such is the race whose ancestors achieved the conquest of Europe some two or three thousand years before the Christian era, subduing gradually the scattered and disorganized tribes of Semitic, Iberian, and Uralian origin. As has been already noted, the two traits of Aryan character which, in addition to the personal valor shared by them with their opponents, especially insured the success of the invaders, were their worship of hereditary rank—a base sentiment, almost unknown to the other great races of mankind—and their ruthless cruelty to the conquered. The former trait gave them union and discipline, the other made them terribly formidable. Both traits have survived to our own day in the dominant class throughout Europe. In the feudal system, the state of society to which these qualities gave rise attained its highest development. A carnival of tyranny, superstition, and cruelty prevailed for several centuries throughout the finest portion of Europe. At length a change occurred. The subject races grew in strength. Various causes conduced to this result—the invention of gunpowder and of printing, the discovery of America, the advance of science, and, finally, the operation of that natural law by which oppressed populations, unless kept down by massacre, tend to increase faster than their oppressors. At last the struggle came to a head in France, just a hundred years ago, when, with the destruction of the Bastile, the Iberian race in that country regained the control of its own destinies, and the ascendency of hereditary rank, with its resulting system of arbitrary, corrupt, and cruel government, was swept away. In the British Islands, where the oppression was less severely felt, the reconquest has advanced, during the past two or three centuries, by more gradual steps—from the Great Rebellion to the Reform Bill of 1832, when the Uralian Saxons regained a substantial equality—and thence to the later movement of the present day, when the still earlier Iberian stratum of population is rising to the light and to its due share in the government.

It is not, of course, to be inferred that the members of any European aristocracy are all necessarily, or even probably, of Aryan descent. There has, undoubtedly, been a large and often repeated intrusion of members of other races into their ranks. In ancient India, where the three higher castes, the Brahmans, Kshatriyas, and Vaisyas, claimed, and doubtless rightly, to be of Aryan origin, it is certain that many Sudras, from the aboriginal races, have found, from time to time, admission among them. But the descendants of these intruders speedily became absorbed in the caste which they had entered, and assumed all its characteristics. When the hereditary or patrician principle was once introduced into Europe by the Aryans—the principle that the son of a noble was superior in political rights to the son of a commoner—a genuine caste was at once established; and this caste, while its membership has been partially changed, has, by the force of position and of interfusion of blood, remained the same in character to our day. Many a Norman baron was of plebeian origin, but the Norman baronage was none the less an Aryan caste. The father of Front-de-Bœuf may have been an Iberian peasant, but his children and grandchildren became the members of a privileged aristocracy, closely allied by blood and intermarriage with all the other European aristocracies, and sharing with them the traits of character which they had inherited from the Aryan conquerors.

If any are disposed, even in the face of the striking evidence of India and its caste-system, to question whether the results of a conquest made in Europe probably not less than four thousand years ago can be so clearly evident at the present day, they may be reminded of two facts which, in different ways, will serve to confirm what has been said on this point. The conquest of France, Spain, England, and other portions of Europe, by the Romans took place about two thousand years ago. The evidences and results of this conquest, in the languages, institutions, features, and character of the conquered nations, are everywhere apparent at the present day. No one dreams of doubting them, and this simply because we have written and monumental evidence of the facts. Why should we doubt that the results of a conquest made two thousand years earlier may survive in equal vigor, though in the nature of things no written or monumental record of it can have come down to our time? The memorials of it which remain are of a different, but, to an ethnologist, not less convincing character. One of these may be noted in the other fact to which reference has been made. A very high authority in comparative philology, Dr. Friedrich Müller, in his great work on Linguistic Science (*Grundriss der Sprachwissenschaft*), after remarking that the numerical system of the Indo-Germanic languages rests on the decimal system, adds that the Celtic alone shows traces of the vigesimal system, which are to be referred to the influence of the Basque language. The Iberian Basques reckon by digits to twenty, which is, in their language, a distinct word, *hogei* (or *oguei*); forty is *berrogei*, "two hogeis"; eighty is "four hogeis"; and ninety-seven would be "four hogeis and ten-seven." The Celtic has a double system. Twenty is *fiche*, a corruption of the Aryan term; for forty the Celt can say either *cethor cha*, an Aryan contraction of "four-tens," or *dá fichit*, "two twenties." Ninety-seven is either "nine tens and seven," or, as in the Basque, "four twenties and ten-seven." Now, the French language, as is well known, adopts both methods, in different parts of its ascending scale. As far as sixty it proceeds by the decimal system; then it abruptly changes to the vigesimal. The Frenchman, when for ninety-seven he says "four-twenties-ten-seven" (*quatre-vingt-dix-sept*), has no idea—unless he is a philologist—that he is translating an ancient Iberian idiom into a corrupt form of Aryan speech. If we consider what this fact really signifies, we shall see that the whole ethnological history of France is embodied in it. This French system of enumeration, now in actual use, tells us that the people who employ it are mainly of Iberian origin; that an Aryan language in its most corrupt and disintegrated form, the Celtic, was once imposed upon them; that this has again given place to the Latin form, which has been further mangled and debased by the influence of a still later Teutonic conquest; and that through the whole of these overlying strata, caste imposed upon caste, the vigorous Iberian element has forced its way to the light, and governs to this day, in this composite population, that most striking manifestation of the intellectual development of a race—its higher numeral system.

It would be easy to add many other illustrations from history, from physical traits, and from linguistic data, but they will hardly be deemed necessary. The conclusion to which we are brought by all the evidence is, that while the conquering energy of the European nations is doubtless due to the infusion of Aryan blood, their higher intellectual qualities and their love of freedom are derived almost entirely from the earlier races, who form the main elements in the mixed European breed. The gradual elimination of the Aryan blood and character, with the return of these earlier elements to ascendency, is the most impressive and important phenomenon in the modern history of Europe, and indeed of the civilized world. We see its results in the extension of free institutions, in the growth of science, in the multiplicity of inventions, in the lessened barbarity of war, in the abolition of slavery, in the increased sense of brotherhood among nations, in the diffusion of education, in the countless societies for charity and for learning, and in all the other evidences of material and moral progress which distinguish our age.

THE AMERICANISTS IN CONGRESS.

THE Seventh International Congress of Americanists met in Berlin, on October 2d, and was opened by Honorary President Gossler, the Prussian Minister of Worship. Although Germany, the speaker said, "had not had any remarkable part in the discovery of America, or in the earliest steps in planting European civilization in the new quarter, it had participated in a rising degree in the scientific discovery of the continent. Americanist studies had, through the brothers Humboldt, already gained burger-rights among us, and had consequently received faithful care; so that the congress finds among us a well-prepared audience, fully appreciating its aims. We understand that a quarter which includes within itself all the zones, all earth-forms, all degrees of civilization, must be closely examined as to its inner relations before the important question whether the peculiar features of the New World indicate any primary connection with the Old can be answered. We recognize, also, that in some districts of America history and prehistory lie far apart; that powerfully organized states, with elaborate constitutions and carefully regulated religious rituals, were destroyed centuries ago, while in the same neighborhoods numerous tribes are still living apparently in a state of nature. The words that were spoken at the first congress in Nancy—"not systems but facts"—have become the programme of the Americanists; doubly valuable in a time when the imagination is too ready to fly heedlessly over wide tracts which disclose their features only to toilsome searchers. Previous congresses have made numerous and important contributions to the structure which we are raising. From meteorology, geography, and the descriptive sciences, to comparative philology and the history of art and religion, the various branches of knowledge have offered their treasures. The circle of studies that help to the investigation of the New World is ever widening, and our extended knowledge of East Asian history and literature is opening to us new means of access to the last of these problems."

Minister Gossler was followed by Signor Guido Cora, who spoke of the discovery in the Vatican archives of important original documents of the time of Columbus.

Dr. Reiss, of Berlin, was chosen president of the congress, and the vice-presidents were Freiherr von Audrian-Werburg, of Vienna; Cora, of Italy; Fabié, of Spain; Gafarel, of France; Morse, of the United States; Netto, of Brazil; and Schmidt, of Copenhagen. At the close of this introductory meeting the president spoke of the condition of Americanistic research and the part which different countries had taken in it.

The first of the regular papers was by Signor Cora, and was on the name of America. The author was not ready to pronounce decisively upon the origin of the name, for various recent investigations had left it uncertain whether it was derived from some word of native origin or was imported. Señor Fabié remarked that the opinion should not be rejected that the name was derived from Amerigo Vespucci, for it had been taken from the maps of that traveler, which were signed with his name.* M. Gafarel spoke concerning the American navigation which was carried on principally by Frenchmen, early in the sixteenth century. The whale-fishery had brought Basques, Bretons, and Normans through the northern seas to Canada, as was shown by many names of points along the coast. In the discussion, M. de la Espada tried to prove that M. Gafarel had exaggerated the part which those discoverers, particularly the Basques, had played. The whale-fishery was not then very extensively prosecuted; but

* M. Jules Marcou says, in the "Bulletin of the Paris Geographical Society," that "it is beyond question that one edition of Vespucci's letter on his third voyage has the name Amerigo in the place of the Christian name; nineteen editions had Albericus, and subsequent Italian editions had Alberico. The one with Amerigo on the title-page was published in 1506, but M. Marcou suggests that this was never intended to be a variation of Alberico, but rather the adaptation of Amerrique, a name already known and applied to the New World, to Vespucci's name to distinguish him, as we say now 'Chinese Gordon,' to distinguish the particular Gordon by suggesting one of his greatest feats."

the presence of the names referred to could be explained by assuming that a few Basques had occasionally reached Canada in Spanish ships. Señor Fabié announced that the Spanish Government was contemplating the full publication, on the approaching four-hundredth anniversary of the discovery of America, of the manuscripts in its archives by and concerning Columbus.

The antiquities of Mexico and South America were the foremost subjects for discussion at the second session. The relics called *agripearls* were the occasion of a long debate. They were formerly regarded as peculiar to the Old World, particularly to Africa, but they had recently been found in all parts of America. According to Tischler's researches, the technic of the colored glass pearls corresponded exactly with that of the Venetian Millefiori glasses, and was so essentially different from that of the ancient Roman glasses that they must be ascribed to the beginning of the Renaissance. M. de la Espada agreed as to the European origin of the pearls, and that they had been used in America as ornaments for horses but not for men. Some ancient Mexican mosaic decorations upon human bones were described by M. Andrée as showing a high development of technic and taste. Only eighteen pieces of this kind are known, which have been placed in European collections. Some of them are masks worked out of real skulls or of wood, and others are figures of animals, etc. The mosaic is composed of small pieces of turquoise, malachite, or mussel-shell, pressed into a foundation of pitch, and forming a carefully elaborated design, or representing in colored shadings the forms of the human face. The Berlin Museum possesses a skull-mask of this kind, a head of a puma, and a figure composed of the fore-parts of two animals.

Prof. Morse presented a paper by Mr. Cushing, on the object and methods of the Hemenway Archæological Expedition into southwestern Central America. The exhibition arranged by the Berlin Museum contains the results of the excavations made by Mrs. Hemenway on the Rio Salado in Arizona. It has been shown that the desert which now exists in that territory was formerly a richly populated and cultivated region. The remains of seven cities and of extensive canals for conducting the waters of the Salado and another river over the land have been discovered. The condition of the ruins indicates that this ancient, pre-Columbian civilization was destroyed by an earthquake, after which the inhabitants probably emigrated to Mexico.

Senhor Netto, of Brazil, had examined a series of mounds of elliptical ground-plan, with a head-shaped annex, in which were found relics of a people who might be distinguished from the present Indians chiefly by the prominence of female influence among them. All the vases and urns, some of which were quite shapely, were marked by ornaments and designs that were exclusively feminine. Numerous thin sheets of earthenware, shaped like a spherical triangle, and often carefully ornamented, perforated at the corners, appear, from the figures on the vases, to have been worn as "fig-leaf" dresses by the women. The very general tattooing of the women's bodies also points to their having held a high position. Later strata furnished remains of another race, among which this exalted position of the women was not apparent.

Prof. Virchow discussed the present condition of knowledge respecting nephrite and jadeite. Désor had assumed, at the Archæological Congress in Brussels, that all the nephrite was derived from two stations in central Asia, and all the jadeite from Burmah. In the mean time, two natural occurrences of nephrite in serpentine had been observed at Zabt, in Silesia, and one in Switzerland, besides a locality of jadeite. Further, a block of nephrite had been found in the Bodensee, which bore plain marks of pieces having been taken from it. Thus, these stones had been found, and evidently worked, in Europe. M. Arzruni had discovered that both species were subject to considerable variations, and that, therefore, every severed specimen found should be tested for determining its origin with respect to the special properties of its material. The specimens sometimes exhibit remarkable relations. Thus, the famous Humboldt axe and another South American hatchet seem to be identical in substance with the European mineral, and a hatchet from Venezuela with one from Hissarlik.

In his remarks upon the anthropological classification of the native Americans, Prof. Virchow admitted that it would not do to speak of a primitive race; yet the ancient skulls are predominantly of a brachycephalic type. These forms seem to have persisted in the South to the present time, but in the North there had been a noticeable transition to long and medium forms. Herr Fritsch suggested an archæological division on the basis of his studies of the hair. He distinguished two groups of people, one with smooth or waving, moderately long, brown hair, like that of the Polynesians, and the other with coarse, stiff hair, inclining to deep black, like that of the Mongols. The former group includes the Central Americans, and, generally, the ancient civilized peoples of South America, and the other the northwestern tribes, with those of single districts in the South. Even if the supposition of a Mongolian immigration in prehistoric times is admissible with respect to this latter group, it can not be held, so far as present researches show, with regard to the ancient civilized peoples.

Herr Nehring, speaking of the domesticated animals of the ancient Peruvians, observed that the subject was scientifically important, because all the other peoples of ancient America were very poor in this kind of property as compared with the Peruvians and Bolivians and some of the Central American peoples; and, secondly, because the influence of domestication on the formation of races could be better followed on these animals than on those of the Old World. We are concerned in Peru especially with the dog, llama, alpaca, and guinea-pig. The speaker had examined eighteen dog-mummies from ancient Peruvian graves, and had determined that they belonged to three different races—a shepherd's dog, a *Dachshund*, and a bull-dog or pug. He believed that the "Inca-dog" was derived, not from other South American *Canidæ*, but from the Mexican wolf (*Lupus occidentalis*), perhaps through the feebler Texan variety; and that several races had been formed from it in Peru through domestication. In this Herr Nehring dissents from and contradicts Von Tschudi's opinion that the varieties had arisen from crossing with European dogs. As the dog and likewise the llama and alpaca are undoubtedly of America, so also, in the speaker's opinion, is the guinea-pig, notwithstanding B. Hensel and other authors believe that it was introduced from Europe. The fact that no remains of guinea-pigs of prehistoric age had ever been found in Europe told against the latter view. A short discussion ensued upon the cropping or amputation of the ears of ancient American dogs, of which Seler had observed evidences in Mexican pictures, and Nehring had found that it had been practiced on Inca-dogs.

Herr Wittmack presented a paper upon the useful plants of the Peruvians, which was based chiefly upon traces found in their graves. Their bread-plant was maize, which their sculptured works and the ornamentation of the pillars of their temples and palaces show was held in high esteem among them. Three varieties of this plant have been distinguished—Indian corn, the pointed-grained, and the umbilicated. Besides maize, a kind of lamb's quarters (the seeds of *Chenopodium quinoa*) and two kinds of pulse were utilized, and the speaker inferred that our bean was derived from America. Small tubers like potatoes, but which could not be determined, and fruits of the anotto, had been observed in the graves.

Concerning the inhabitants of Mexico at the time of the conquest, Herr Hartmann remarked that the reports of the *conquistadores* left us in the dark, and we were therefore sent to the ancient representations. His own researches indicated that Montezuma's people had the same physical race characteristics as are exhibited by the present Dakotas, Pawnees, Comanches, etc. The Araucanians, Patagonians, and Fuegians might likewise be regarded as related to the Aztecs; in fact, he had often found among them the peculiar, dreamy, melancholy facial expression which is ascribed to the ancient Mexicans. In the light of the later researches, Colombia, the country of the Chibchas, the third most important people in pre-Columbian America, obtains a special significance, because it was the region which at the time of the discovery prevented contact between Mexican and Peruvian civilizations. The speaker produced linguistic evidence that the Chibchas, who were resident in the heart of Colombia, were not an immemorially isolated people in the sense in which they had formed one of the puzzles of the New World. They had near relatives in the people of Costa Rica and northern Colombia. People of Chibcha and Mexican origin met in Costa Rica. According to these evidences the dispersion of the Chibcha people may be historically conceived by assuming that originally dwelling near Cundinamarca, they afterward spread out, and were still later scattered by the influx of wild Brazilian tribes and driven to the mountains, where they lost their connections. A paper was also presented by Herr Uhle on the primitive history and wanderings of the Chibchas.

Other papers were read by Messrs. Borsari, on the constructions of the ancient Peruvians; Müller, on the Sambakis of Brazil, a people who had a prehistoric civilization; Von den Steinen, on his second journey to the Xingu, in which certain conclusions, particularly those respecting the relationship of the Tupi and the Caribs, which he had formed in his former journey, were confirmed; and on the Calendar-stone and various antiquities, statuettes, and potteries of Mexico and Central America. M. Hamy made some remarks at the close of the meeting on the falsification of American antiquities, which had reached a great height, and exhibited an album containing specimens of the counterfeits. —*Translated for the Popular Science Monthly from Humboldt.*

The importance of educating youth for the duties of citizenship is made more obvious at every general election. As indicated by Prof. Woodward, of St. Louis, some months ago, a course of civics in the public schools should embrace an analysis of our scheme of government, national, State, and municipal, with a general statement of the functions of each; the necessary expenses of each of the governments, with a detail of the institutions that must be supported by taxation; the methods in use of levying and collecting taxes; and the duties of citizenship—such as the maintenance of individual independence; the contribution of one's share in taxes to the necessary expenses of government; participation in all measures necessary to secure the selection of faithful and competent servants to discharge the duties of government; the cultivation of a proper public opinion in favor of honesty, temperance, and the refinements of civilized life; and the contribution of something, small or great, to the common weal, beyond the duties specially named, whereby the world may be the better for one's having lived in it.

SKETCH OF PIERRE BELON.

"IN 1555," says M. Louis Crié, "Pierre Belon, of Mans, well known by his travels in Italy, Greece, and the East, revealed himself as an observer of great sagacity and as a bold thinker. With him came at once the end of compilation and the beginning of observation. He added to the common treasure of knowledge more wealth than all his predecessors from antiquity and all his contemporaries put together." M. Gustave Tissandier calls him one of the great *savants* of the sixteenth century, who, like his contemporary, Bernard Palissy, would rather study facts in the book of nature than in men's books—"a conscientious observer, fascinated with the truth, we may consider him one of the initiators of modern natural history."

Pierre Belon was born at Soulletière, near Mans, in 1517, and died in 1564. His tastes for studies in natural history were developed at an early age, and were encouraged by his friend René de Bellay, Bishop of Mans, with whose aid he entered upon the study of medicine at Paris. There he formed a friendship with the poet Ronsard. Having obtained his doctor's degree, he went, in 1540, to Würtemberg, to attend the lectures of the botanist Valerius Cordus. In company with his teacher he traveled through Germany and Bohemia. The country was greatly excited over the controversies of the Reformation; and at Thionville, on his return journey home, he was arrested by the Spanish occupants, under suspicion of being a partisan of the new doctrines. He was obliged to buy his freedom with funds that were advanced by a learned gentleman named Dehamme, who was a great admirer of Ronsard. Returning to Paris, he found generous protectors in Bishop Duprat of Clermont, the Cardinal of Lorraine, and the Cardinal of Tournon. Tournon provided him with quarters in the Abbey of Saint-Germaine, and advanced the cost of the voyages which he desired to make for prosecuting his studies. The words in which Belon conveyed his request for this aid at once attest his earnestness in the pursuit of his object, and illustrate the spirit of a time when the small were free to call upon the great for help in such matters. "When you know," he said, "the desire that I have to obtain knowledge of the things pertaining to the material of medicines and plants, which I can not well acquire except by a long pilgrimage, you will be pleased to command me to go and seek them in distant regions, in the places of their origin."

Belon left France at the beginning of 1546, and was gone between three and four years. He went to Crete and Constantinople; then visited Lemnos, Mount Athos, Thrace, and the Grecian islands; thence went to Egypt, where he made observations that have become famous at Alexandria and Cairo; traveled through Palestine, Syria, and Asia Minor, to Constantinople; and returned to France, by way of Rome, during the year 1549. To his friend Ronsard this journey had all the adventure and importance of a general exploration of the globe, and he celebrated it appropriately in verse, glorifying Belon as if he had been one of the greatest of navigators.

The accounts of his observations during this great tour were published in the remarkable book known as "The Singularities," the full title of which is, "Les observations de plusieurs singularités et choses mémorables trouvées en Grèce, Asie, Judée, Egypte, Arabie, etc., et autres pays estranges" ("Observations of many Singularities and Memorable Things found in Greece, Asia, Judea, Egypt, Arabia, and other Foreign Countries"), Paris, 1553. It was illustrated with numerous figures of animals and birds, etc., engraved on wood. This book abounds in novel observations on the natural history and geography of the countries visited, with descriptions of their monuments or ruins, and of the manners and customs of their people. One of the most interesting parts of it, according to M. Louis Crié,* is the story of his travels in Egypt, in which "we read with pleasure the pages which he has devoted to the geography, ethnography, medicine, the fauna and flora of that strange country. Very curious details are found in his book respecting Alexandria, the manners of the Alexandrians, the city of Rosetta, the fishes of the Nile, the houses and gardens of Cairo, the pyramids, "the mummy," the plants that grow around Suez, etc. The same work contains a plan of the city of Alexandria and views of the island of Lemnos, Mount Athos, and Mount Sinai. Although the geometry of these cuts is elementary, they give evidence of careful observation. Belon drew after nature, and for the first time, such animals as the ichneumon, the hippopotamus, the crocodile, the chameleon, the hawk, the black ibis, and several fishes. His 'Singularities,' replete with local originalities, is remarkable for the amplitude of the information it affords. We notice in it rigorous good faith attentive to the discovery of the significance of facts without dissimulating in anything." A queer description is given of the giraffe, "whose fore-feet, when it runs, go together. It lies with its belly against the ground, and has callosities on the chest and thighs like the camel. It can not feed on the ground standing without spreading its fore-legs away out, and that is very hard. Hence it is easy to believe that it does not live in the fields, but upon the branches of trees, having a neck so long that it can extend its head to the

* "Les Voyages de Pierre Belon." "Revue scientifique," 1883, No. 7.

height of a short pike. And having drawn it from nature, we here present its portrait."

In 1556, King Henri II granted Belon, in recognition of his work, a pension, which appears to have never been anything but honorary. He was also given a residence in the Château de Madrid, in the Bois de Boulogne, where, during the remaining years of his life, he studied natural science and wrote his celebrated books. One evening in 1564, as he was crossing the Bois, on the way to visit his friend Jacques du Breuil, he was attacked, by highwaymen, it is supposed, and killed, in the forty-eighth year of his age.

Fig. 1.—Portrait of the Giraffe (after Pierre Belon).

The "Natural History of Fishes"* marks Belon, according to M. Crié, as the founder of modern ichthyology. "While rectifying and enlarging what Aristotle had said, the Mansian naturalist gave a positive basis to icthyology by descriptions and figures of a considerable number of species. In the 'Aquatilibus' are described a hundred and ten fishes, of which twenty-two are cartilaginous, seventeen fresh-water, and the rest sea fishes. . . . The figures representing them are easily recognizable, notwithstanding the simplicity of the style of the wood-engravings.

"His philosophical mind had a very correct appreciation of the genera. His groupings were made with a surprisingly just instinct. To an indefatigable activity he joined vast erudition. He brought to the front the study of nature and of the books that treat of it. . . . The feature that especially prepared new bases for the science of fishes was his observations on the thoracic and abdominal splanchnology of those animals. He gives with infinite sagacity correct details respecting the liver, its shape, and the number of its lobes; the spleen, its position, vol-

* "Histoire naturelle des estranges poissons marins, avec le vraie peinture et description du dauphin et de plusieurs autres de son espèce," 1551, with woodcuts; "Nature et diversité des poissons, avec leurs portraicts," 1553; "De aquatilibus libri duo, cum iconibus ad vivam ipsorum effigiem quoad fieri potuit," 1553.

ume, and size; the gall; the intestine, its direction and disposition; and the pyloric appendages, which he called *apophyses cæcos.* Long before the fine researches of Cuvier, Mierendorff, Valenciennes, and Duvernay, Belon first studied the conformation of the liver in more than thirty species of fishes." We copy from this book a curious picture of a hippopotamus of the Nile devouring a crocodile (Fig. 2). The germ of embryology appears

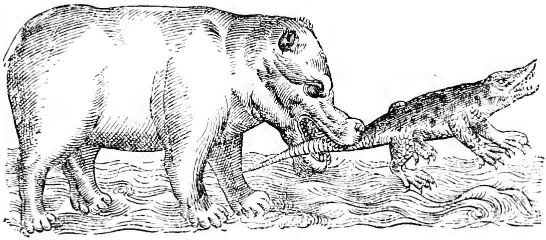


Fig. 2.—The Hippopotamus of the Nile (after Pierre Belon).

in a most remarkable manner in a representation, in the first of the books named in our note, of the matrix and embryo of the porpoise. These works, in which the genius of Belon showed itself to be of a superior order, were followed by the book on the "Nature of Birds,"* which is described by M. Crié as an "imperishable work, a fruitful source of instruction to the philosopher and the naturalist." It was the crowning work of Belon's life, and marks an era in the history of science, for in it was developed and illustrated the idea of a uniform plan of structure among animals. Belon had already in his "Fishes" and his descriptions of plants definitely applied the distinctions of genera and species, and had invented the binary nomenclature to take the place of the long-drawn and often not satisfactory descriptions with which previous authors had tried to mark these differences. More than one hundred and eighty years before Linnæus he had brought similar plants into single groups, to which he applied common or generic names—as *Fagi, Ulmi, Fraxini, Aceres, Corni,* etc.—and had then substituted for the usual descriptive phrase a specific name, sometimes an adjective relating to an external quality, as *Smilax aspera, Smilax lævis, Papaver corniculatum;* sometimes one of the common names of the period or of a celebrated person.

At the very beginning of his book on "Birds," Belon placed a representation of the skeleton of a bird face to face with a human skeleton, and marked by a common lettering the features and parts common to both. By this, creating the comparative method,

* "Histoire de la nature des oyseaux, avec leurs descriptions et naifs pourtraicts retirez du naturel, escripte en sept livres," 1555.

he opened a new pathway in science. The thought of unity thus presented for the first time by Belon is the same that was declared two hundred and fifty years afterward by Geoffroy Saint-Hilaire. Belon's division of birds—into the *Fissipedes* and the

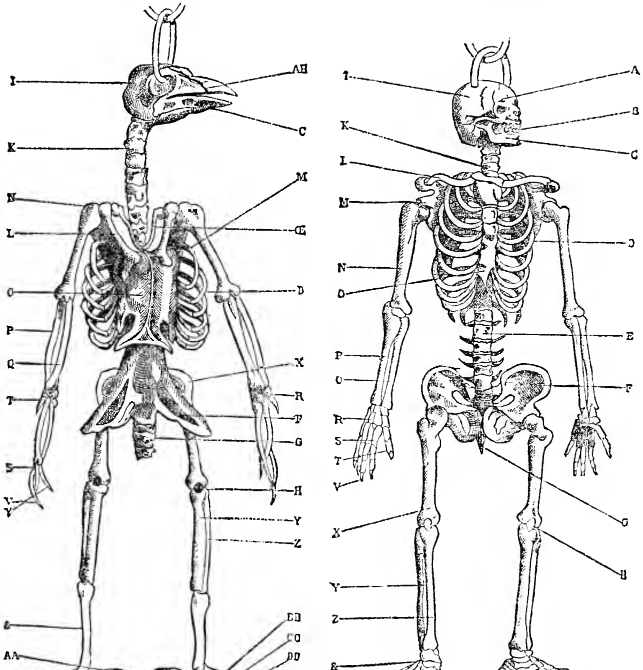


FIG. 3.—SKELETONS OF A BIRD AND OF MAN.

AB. Birds have no teeth, but a cutting beak, strong or weak, large or small, according to the matter they have to pick to pieces and on which they live. M. Two long and narrow scapulæ, one on each side. Œ. Bone called the merry-thought, or breast-bone, found in no animal except the bird. D. Six ribs, attached to the chest of the stomach in front, and behind to the six vertebræ of the back. F. The two bones of the hips are long, for there are no vertebræ below the ribs. G. Six bones of the rump. H. The round bone of the knee. I. The sutures of the skull do not show unless it is boiled. K. Twelve vertebræ of the neck, and six of the back. L. The two key-bones. N. The bones of the arms or shoulders. O. The chest of the breast. P. The little bone of the elbow. Q. The large bone of the elbow. R. The bone of the wrist, called carpus. S. The knots and articulations, called condili. T. The pinion, called appendix, which is related to the wing as the thumb to the hand. T. The bone after the wrist called metacarpium. U. The extremity of the wing, which is like our fingers. V. A number of bones at the end of the wing, two of which have the form of netting-needles (or shuttles); one larger and the other smaller, which is proportioned in the bird as in us the hollow of the hand, which is called in Greek *Thenar*, and in Latin *Palma*. X. The large bone of the thighs, one on each side. Y. The large bone of the leg. Z. The small bone of the leg. &. The bone given for the leg to birds, corresponding with our heel. AA. Just as we have four (*quatre*) toes on the feet, so have birds four (*quatre*) fingers, the hinder one of which is given in proportion as the big toe with us. BB. Four articulations in the outer finger. CC. Three articulations in this finger. DD. Two articulations in this finger, as also in the hinder one.

Palmipedes—is precisely that of Cuvier which is taught in elementary books. Other correspondences of classification with the classifications of Linnæus and Cuvier will be found in the following table:

Belon's classification.	Classification of Linnæus.	Cuvier's classification.
Day and night birds of prey.	Accipitres.	Birds of prey.
Birds having flat feet and swimming on the water.	Anseres.	Palmipedes.
Birds having flat feet, etc.	Scolopeces, or Grallæ.	Waders.
Birds that build their nests on the ground.	Gallinæ.	Gallinaceæ.
Birds that are found everywhere.	Gallinæ Passeres.	Gallinaceæ Passeres.
Birds that haunt hedges, sticks, thickets, thorns, and briers.	Passeres.	Passeres.

The main classification of birds has thus not been materially changed since 1555. The portrait of a wren is a specimen of the ordinary illustrations in "The Birds" (Fig. 4).

Belon composed a treatise on agriculture,* in which was included a list of exotic plants which it would be desirable to acclimate in France, and suggested the foundation of an establishment for that purpose. Something of the kind was carried out under Belon's direction by René de Bellay on his estate of Touvoy, near Mans.

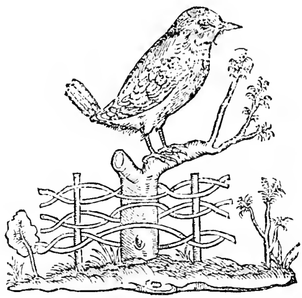


FIG. 4.—THE WREN (after Pierre Belon).

Besides the works already described, Belon published a history of conifers † and a treatise on the funeral monuments and sepultural usages of the ancients and the substances used by them for the preservation of bodies.‡ According to Renouard, he translated the treatise of Dioscorides into French. He also made a version of Theophrastus's "History of Plants," which has been lost. The magnitude of his works indicates that he had an enormous capacity for labor. His writings on anatomy, botany, agriculture, and medicine, as measured by M. Crié, display a rare critical faculty, and nearly all his observations overreach the horizon of his epoch.

A statue of the great naturalist was unveiled at Mans on the 9th of October, 1887, with an address by M. Crié. The portrait we publish is a copy of the engraving that was prefixed to the "Singularities," and represents Belon in his doctor's cap.

* "Les remonstrances sur le défaut du labour et culture des plantes, et de la connoissance d'icelles, contenant la manière d'affranchir et apprivisoir les arbres sauvages," 1558.

† "De arboribus coniferis, resiniferis, aliisque nonnullis sempiterni fronde virentibus," 1553.

‡ "De admirabili operum antiquorum præstantia," 1553.

CORRESPONDENCE.

THE GREAT SOUTHERN TORTOISE AGAIN.

Editor Popular Science Monthly:

MY object in writing to you on November 1, 1888, was, as I then stated, to call the attention of Prof. Shaler to the error into which he had fallen in attributing to the *gopher* (a tortoise) the habits of the *salamander* (*Geomys pinetis*), a small rodent. I did not expect my remarks to be published by you, but I did expect Prof. Shaler, as of his own motion, to make through your pages some explanation or acknowledgment of his blunder; and had you been content to simply print my note in your January number, I should not now feel called upon to make further reference to the subject. The only inference to be drawn from your editorial comments upon my note is that you have not read Prof. Shaler's article on the "Habits of the Great Southern Tortoise," which appears in your journal for November, 1888, and to which my note refers!

The question is not, as you appear to suppose, which animal, the *gopher* or the *salamander*, produces the greater effect upon the soil of Florida. What I wish to point out is the fact that a reputed scientist has published in a scientific journal an article which ascribes to one animal habits which are impossible to it and which belong to a totally different animal. He then proceeds to speculate, from these false premises, as to "the limits of evolution under the influence of natural selection"; and, naturally enough, in his efforts to reconcile the irreconcilable, finds himself reduced to the necessity of "begging the question." He would have saved himself all this trouble and perplexity if, in describing the *habits* of the animal, he had written *salamander* wherever the word *gopher* now appears in his paper.

Very respectfully, C. C. Byrne,
Surgeon United States Army.

Washington, D. C., *January* 4, 1889.

THE WAYS OF BEES.

Editor Popular Science Monthly:

Sir: I see that you too have copied that "bees and pigeon race hoax," in your notes on page 287 of the December number, when "twelve bees, having been rolled in flour to mark them, and twelve pigeons belonging to a fancier in the village, were let loose about a league away. The first bee reached home a quarter of a minute before the first pigeon, and the rest of both squads arrived at the same instant, a few moments afterward." This is a *canard*. Take bees three miles from home and liberate them, and they will rise and *circle round* the place where they find themselves till they mark the location; then they will fly away in search of food, and, when they are loaded, will *return to the spot they left*, not to their old home, three miles or so away. Respectfully yours,

Mahala B. Chaddock.

Vermont, Ill., *January* 10, 1889.

[The item in question was translated from "La Nature," of September 8, 1888; a journal that is not usually careless in scientific matters.—Ed.]

EDITOR'S TABLE.

WHAT MAKES SUCCESS IN LIFE.

WHEN the storm of the French Revolution was over, the Abbé Sieyès, who had taken a prominent part in it at the outset, was asked, somewhat in derision, what he had done in that critical time. "*J'ai vécu,*" was his reply: "I lived through it." This, indeed, was no mean success for any actor in that bloody drama; and the philosophical abbé might well take a little pride in the adroitness that had enabled him to keep his head on his shoulders. Taking a broad view of the matter, survival is the best test of success; but then survival may either be of the whole or of a part only, of much or of little. The man may survive as a living organism—a zoölogical specimen—but character may be gone, or hope, or health, or happiness. The truly successful are they who carry with them to the end that which makes life worth living, who retain the sense of a purpose and meaning in life, and who do not, like James Mill, father of John Stuart Mill, feel that, when the freshness of youth is past, human existence is a somewhat dreary thing.

To the multitude perhaps success in life is gauged by a money scale: to be rich is to be successful, to be poor is to be unsuccessful; but this is far from being a desirable standard to erect. But few can reap success according to this idea; and the rest must reap failure and discontentment. A truer and better conception is that the man who develops his faculties and cultivates his dispositions aright, who, amid the warfare and vicissitudes of life, keeps his judgment sound, his aims sincere, his temper sweet, his domestic and social relations duly adjusted, and who thus in a true sense *lives* through his whole career, is the type of a successful man. The Roman poet Horace, whose good sense strikes us at every turn, must have had this idea to some extent; since the thought with which he feels he could satisfy himself were his existence to be suddenly brought to a term is that expressed in the word "Vixi," the exact equivalent of the Abbé Sieyès's "J'ai vécu," "*I have lived.*"

The education, then, that we want is an education for life; we want to be taught how to live, how to make the best of ourselves, of our circumstances, of our relations, of our environment generally. Is this the type of education prevalent in the present day? We fear not. The dominant idea in most—we might almost say in all—of our schools is that of a purely selfish success, which means, if realized, a quite incomplete success, one that leaves the general life of the man or woman essentially unblest. What our young people need above all things to be taught is to know themselves and their surroundings, and to understand the true objects of life. They want an education dominated by common sense and right motive; and the few who get such an education are not likely to fail of success in any sense. It is a great thing to be taught the simple habit of verification: one who has this will score many a point even in the competition of the market-place. It is a great thing to be taught, with conviction, that a well-regulated life is always worth living, and that this world is worth doing justice to. Many are stranded in mid-life simply because they have not taken things seriously enough, because they have trusted to chance rather than to doing with their might what their hands found to do. No time is unsuitable for overhauling one's scheme of life, and trying to find out its weak places if it has any; but perhaps the beginning of a new year offers the greatest advantages for such a review. All should aim at a true success in life; and a true success is within the reach of all, if prudence but take the helm.

COMPETITION.

The article by Mr. George Iles, which we publish in our present number, draws attention to the economic waste resulting from unrestricted competition, and suggests the action which the State may hereafter be compelled to take, in the public interest, to check the undue greed of individuals and corporations. Competition, as it seems to us, is not a thing which there is any use in opposing or condemning. It is simply, in the last resort, individual self-assertion; and as long as there are individuals they will assert themselves. Sometimes it occurs to a number of individuals that they can assert themselves—i. e., promote their own interests—more effectually by uniting their means and their efforts than by acting in complete independence of one another: then we have combination or co-operation; but the consolidated body still has its own competitors and its own battles to fight. From this we gather that there are certain unnecessary forms or modes of competition, and that experience points out, from time to time, what these are; but that competition, in the broad sense, is as lasting as human nature. Now, if we differ at all from our respected contributor, it is where he suggests governmental interference to check certain apparently unhappy results of private enterprise. We do not see how the Government is going to help us in the least; and, as it happens, the interference that our contributor invokes is actually for the purposes of *restoring* competition in cases where he supposes it to have been arbitrarily arrested. He thinks that all trusts whose object is simply to raise prices by restricting competition should come under a legislative or judicial ban. To us the idea of forcing people to compete by legislative authority, whether they wish to do so or not, is a trifle extravagant. To our apprehension the best thing the State can do is to let the whole business alone, and leave individuals to find out for themselves under what circumstances competition is the only possible *régime*, and under what circumstances co-operation will serve a better purpose. It is not in the least likely that mankind at large is going to pay tribute to any serious extent to great corporations. Even an increase in prices is not a sure sign that the public is suffering, since the consolidation that has rendered the increase possible may have liberated a vast amount of capital and thrown it into more productive channels. Extremely low prices are too often the concomitant of business disorganization and the destruction of capital. The *régime* of freedom is the one that will suit us best. Give us freedom, and we can take care even of the trusts. A community that has been taught to depend on private initiative, and where legal *privilege* is unknown, has nothing to fear from any quarter.

The article by Mr. J. M. Arms, on "Natural Science in Elementary Schools," in this number of the "Monthly," contains a notably clear and vigorous statement of the worth of real science-lessons to young pupils, together with some practical aid for teachers in giving such lessons, and a sketch of the growth of the sentiment in favor of science-teaching. This growth was undoubtedly aided by the attitude on the matter taken by the American Association for the Advancement of Science, which, at its meeting in 1879, appointed a committee, of which the former editor of this magazine was chairman, to consider the subject of "Science-Teaching in the Public Schools."

The report of this committee was presented to the Association at the Boston meeting in the following year. It was drawn up by the chairman, and takes the ground that the quality of the science-teaching, where there was any in the public schools at that time, was generally so unsatisfactory that it ought to be entirely recast before any extension of it would be desirable. A point to which Prof. Youmans called special attention is, that science was being taught by the old methods devised for other subjects, which were entirely unsuitable for the new study. In the words of the report, "Through books and teachers the pupil is filled up with information with regard to science. Its facts and principles are explained as far as possible, and then left in the memory with his other school acquisitions. He learns the sciences much as he learns geography and history. Only in a few exceptional schools is he put to any direct mental work upon the subject-matter of science, or taught to think for himself." The deceptive quality of oral lessons, alluded to by Mr. Arms, is thus pointed out in this report: "Instruction in elementary science is now," when the pupil enters the grammar school, "to be carried on by what is known as oral teaching. This method, as extensively practiced in the grammar grades of the public schools, is everywhere growing in favor, and we are once more told that it is a successful revolt against book-studies. It is chiefly applicable to the sciences, and its cardinal idea is instruction without a text-book. This looks fair, but it is delusive. The method does not remove the book that the pupil may come at the phenomena, but it removes the book that the teacher may take its place. Oral teaching is class instruction, in which information is imparted in a familiar manner, with the view of awakening the interest of the class. But, so far as real science is concerned, it is doubtful if this method is not worse than the one it replaces. . . . The value of educational systems consists simply in what they do to incite the pupil to help himself. Mechanical school-work can give instruction, but it can not develop faculty, because this depends upon self-exertion. Science, if rightly pursued, is the most valuable school of self-instruction. From the beginning, men of science have been self-dependent and self-reliant because self-taught; and it is a question whether they have been most hindered or helped by the schools."

LITERARY NOTICES.

The Eulogy of Richard Jefferies. By Walter Besant. New York: Longmans, Green & Co. Pp. 384. Price, $2.

The name of the subject of this book may not be familiar to all the readers of the "Monthly." An insight of the quality of the man may, however, be given by the fact that Mr. Besant started to write his life without ever having seen him, and ended by calling the biography a eulogy. Mr. Jefferies was born in 1848, and died in 1886, only thirty-eight years old, and in only ten of those years did he do work suitable to his powers and fitted to bring him recognition; but the work of those ten years has given him a place among students of Nature and masters of English writing alongside of Gilbert White and Thoreau. We doubt if he has ever had a rival as an accurate describer of Nature in her various aspects and minute details, who could at the same time command the sympathies of the reader in what almost runs into "cataloguing." His early surroundings and training were most favorable to the cultivation of those habits of close observation which he brought into play in his later writings, and it was his misfortune that he spent so many of his few years in vain efforts to do what he was not fitted for. Mr. Jefferies was born, being descended from a long line of independent farmers, at the farm-house of Coate, near Swindon, in Wiltshire, in a country of downs and abounding in ancient monuments. Of the territory around the old house he knew "every inch of ground, every tree, every hedge," and the land of it which lies within a circle of ten miles radius "belongs to his writings." The family "seem to have inherited, from father to son, a love of solitude and a habit of thinking for themselves." Richard's father, who is drawn in his books as Farmer Iden, and a man of this sort, "took him into the fields and turned over page after page with him of the book of Nature, expounding, teaching, showing him how to use his eyes, and continually reading to him out of that great book." He early showed an inclination to literature, and the position as reporter on two or three of the local newspapers enabled him to make a kind of a living while he tried to write novels, work for which he had none of the essential qualifications. The account of his life for several years is a record of ambitious attempts, high hopes, and bitter disappointments, as story after story was submitted to publishers and refused. His first success came in 1872. The relations of the farmer with the agricultural laborer had become a living question, and Jefferies, feeling that he knew all about the subject, wrote a long letter upon it, which was published in the "Times," with an accompanying "leader," and was answered and commented upon in other journals. In the next year he published an article in "Fraser's Magazine" on "The Future of the Farmer," and that attracted attention. It was followed by two other papers of similar character; and in 1876, Jefferies, having discovered his true field, began that series of papers which, afterward published in books, bid fair to give him a permanent place among the most famous descriptive writers of rural nature and of animal and plant life. The first book, "The Gamekeeper at Home," secured him recognition at once, and brought proposals from publishers. Among others, Mr. Longmans invited him to write a book on "Shooting." He could not do it, because he could not work up ideas that were not of his own originating; but the thought was the seed of "The Badminton Library." The character of his later books is correctly described by Mr. Besant when he says that in them "the whole of the country life of the nineteenth century will be found displayed down to every detail. The life of the farmer is there; the life of the laborer; the life of the gamekeeper; the life of the women who work in the fields and of those who work at home. He revealed Nature in her works and ways; the flowers and the fields; the wild English creatures; the hedges and the streams; the wood and the coppice. He told what may be seen everywhere by those who have eyes to see," and he began "to write down the response of the soul to the phenomena of Nature, to interpret the voice of Nature speaking to the soul. . . . He draws as no other writer has done the actual life of rural England under Queen Victoria." The secret of the perfect execution of these works is found in examining the note-books which he habitually kept, recording daily observations and phenomena, a few specimens of which are printed, and the reading of which "is like reading an unclassified index to the works of Nature." Jefferies was disabled by illness during the last five years and a half of his life, and had to work by the hands of others. Yet some of his best essays were produced during this time. Among them were "The Red Deer," a minute account of the natural history, etc., of these animals, to observe which he had gone all over Exmoor on foot; and the essay entitled "The Pageant of Summer," in which he reached his highest point, but which "was written while he was in deadly pain and torture." He died poor, and a subscription was taken among the admirers of his writings to place his family in a comfortable position.

Burial-Mounds of the Northern Sections of the United States. By Cyrus Thomas, Ph. D. Washington: Bureau of Ethnology. Pp. 119.

This monograph is an advance extract from the fifth annual report of the Bureau of Ethnology. It deals with the burial-mounds of the Wisconsin, Illinois, Ohio, and Appalachian districts, which areas are regarded as having been occupied by different tribes. The effigy-mounds form the distinguishing feature of the Wisconsin district. The works of the Illinois region are mostly small conical tumuli, containing rude stone or wooden vaults, and further characterized by the scarcity of pottery vessels, the frequent occurrence of pipes, the presence of copper axes, etc. Among the peculiar features of the works in the Ohio district are the great circles and squares of the inclosures, the long parallel earthen walls, the so-called altars within the mounds, and the numerous carved stone pipes. The mounds of the Appalachian district resemble those of the last-named area, in containing altar-like structures and numerous stone pipes. The peculiar features are the mode of burial, the absence of pottery, and the numerous polished celts and engraved shells found in the mounds. The other regions mentioned but not treated in this monograph are the New York, middle Mississippi, lower Mississippi, and Gulf districts. This districting, however, is put forward as a working hypothesis rather than as an established arrangement. Prof. Thomas gives brief descriptions of the leading types found in the different northern districts mentioned, confining himself chiefly to the explorations made by the bureau assistants. These accounts are illustrated with forty-nine cuts and six plates. He concludes, from the results of these explorations, that each of the tribes inhabiting one of these northern districts had several modes of burial, differing with the social position of the deceased; that the custom of removing the flesh before the final burial was quite general, the bones of the common people being often gathered into heaps over which mounds were built; that usually some religious ceremony in which fire played a part was performed at the burial, but that there is no evidence of human sacrifice; that nothing in the character or contents of the mounds indicates that their builders had reached a higher culture status than that in which some of the Indian tribes were found at the coming of the Europeans; that the beginning of the mound-building age does not antedate the fifth or sixth century; and that the custom of erecting mounds over the dead continued in some localities into post-Columbian times.

An Introduction to Entomology. By John Henry Comstock. With many Original Illustrations, drawn and engraved by Anna Botsford Comstock. Part I. Ithaca, N. Y.: The Author. Price, $2.

Prof. Comstock designs that this work shall enable students to acquire a thorough knowledge of the elementary principles of entomology, and to classify insects by means of analytical keys similar to those used in botany. As the completion of the work has been delayed by other duties, the author has thought best to issue this part by itself. The first three chapters are of an introductory character. In Chapter I the general characters and metamorphoses of insects, which term the author restricts to the *Hexapoda*, are stated; Chapter II is a description of the anatomy of insects, fully illustrated; and Chapter III is devoted to the classification of the *Hexapoda*. The remaining chapters consist of descriptions of the more common or conspicuous species in each family, together with keys by means of which the student can readily determine to what family any insect of which he has a specimen belongs. In many cases tables of genera are also given. Much space has been devoted to accounts of the habits and transformations of the forms described. The needs of agricultural students especially having been kept in view, those species that are of economic importance have been described with considerable fullness. The rest of the work will be published as soon as practicable. In addition to the systematic part, in which four more orders—*Lepidoptera*, *Diptera*, *Coleoptera*, and *Hymenoptera*—remain to be described, there are to be chapters on the means of destroying insects or of preventing their ravages, on the collection and preservation of entomological specimens, on entomological supplies, a classified list of entomological works, a glossary, and an introductory chapter. This part comes in paper covers. It is well printed, and is abundantly illustrated.

Gleanings in Science: A Series of Popular Lectures on Scientific Subjects. By Gerald Molloy, D. D., D. Sc. London and New York: Macmillan & Co. Pp. 352. Price, $2.25.

With one exception, the lectures which make up this attractive volume were delivered before the Royal Dublin Society. In preparing them for publication the author has used whatever materials have come into existence since the lectures were delivered, so as to present the latest available information in each case. The subjects treated are included in the sciences of heat and electricity, except the Alpine glaciers, which are described in a lecture delivered to a young men's society. There are two lectures on the modern theory of heat as illustrated by the phenomena of latent heat, one of these dealing with the latent heat of liquids, the other with the latent heat of vapors. Lightning and thunder are treated in one lecture, lightning-conductors in another, and the storing of electrical energy in a third, while the recent controversy in England on lightning-conductors is sketched in an appendix. The electric light is the subject of two lectures; one telling how the electric current is produced, the other how the current is made to yield the light. Two lectures also are devoted to the sun as a store-house of energy: one describing the immensity of the sun's energy, the other discussing the theories as to its source. The treatments are thoroughly popular, avoiding mathematics and technical language, and, besides setting forth the present state of the science in each case, touch upon the history of the subjects and the practical applications of the principles stated. Descriptions of experiments are introduced, which the reader is helped to realize by many excellent illustrations. The lecture on "The Glaciers of the Alps" is especially fascinating, and owes part of its interest to the quotations and cuts borrowed from Mr. Whymper's "Scrambles among the Alps." The whole volume, in manner as well as in matter, reminds one of Tyndall's popular works, and will be found very attractive reading for any one who has an intelligent interest in science.

The Civilization of Sweden in Heathen Times. By Oscar Montelius, Ph. D. Translated by Rev. F. H. Woods, B. D. London and New York: Macmillan & Co. Pp. 214. Price, $4.

As in most countries, the archæological chronology of Sweden embraces a stone, a bronze, and an iron age. The stone age is regarded as extending to about 1500 B. C. In his chapter on this period the author describes a considerable variety of tools and weapons of stone which have been dug up in Sweden, and tells how archæologists have proved that such articles could be made without the use of metals. He sets forth also what information these relics afford as to the customs and habits of the people who made them. The graves belonging to the same period are also described. It appears that the Swedish common people of later times, finding these stone implements, called them "Thor's bolts," and regarded them as a sovereign protection against lightning-strokes and other disasters. "Even at the present day it is often impossible to induce people to sell antiquities of stone, because they believe that by so doing they lose a protective amulet." The articles which characterize the bronze age, extending from about 1500 to 500 B. C., were nearly all formed by casting; it is only toward the close of this period that traces of the use of the hammer in working the metal are found. While some effort toward ornamentation appears in the relics of the stone age, much more scope was given to this taste when metal came into use. The works of the earlier part of the bronze age are decorated with fine spirals and zigzag lines; those of the later part of this period do not display spirals of the same shape, but the ends of rings, knife-handles, etc., are often rolled up in spiral volutes. Prof. Montelius, in another work, has distinguished six subdivisions of the bronze age, but does not take space here to state the data on which they are based. Articles of horn, bone, wood, and leather, belonging to this period have been found, and even woolen clothing which had been buried in oak-tree coffins. The iron age is reckoned from 500 B. C. to near 1100 A. D., and is treated in four subdivisions. The author is convinced that the arts of working both iron and bronze were learned by the inhabitants of Sweden by intercourse with other nations, and not brought into the country by any immigration of a new people. The relics of this age which have been found are of great variety, and many of them bear decorative figures much more elaborate than those on the bronze implements, and include some very pleasing designs, while inlaying and plating with silver and gold were also practiced. A large number of stones bearing inscriptions in Runic letters date from this period. A map and two hundred and five cuts illustrate the text. Both this work and Dr. Molloy's "Gleanings in Science" would be more valuable to students if they were provided with indexes.

THE HOME-MAKER. A Monthly Magazine. Edited by MARION HARLAND. Vol. I, No. 1. October, 1888. New York: The Home Maker Company. Price, 20 cents a number; $2 a year.

"THE HOME-MAKER" has an honorable and important field. A moment's reflection will call to mind a host of ways in which the character of the home acts upon the comfort, habits, health, dispositions, manners, morals, and culture of the inmates—directly by its effect upon them while at home, and perhaps indirectly by driving them to seek pleasure away from home. Much can be done to improve the character of the home by the teachings of a good magazine. A home modeled after the pattern of "The Home-Maker" would be a nice, comfortable, pretty, refined place, with much leisure and little care. Such a place would insure the wife and mother being always happy; would give the children soft and pleasant surroundings to grow up in, and would offer to the husband the most complete contrast to the hard, anxious struggle of his daily business. This magazine is adapted especially to ladies in comfortable circumstances who wish to know how to beautify their homes, and how to free housekeeping of its inconveniences. Nearly all the articles are adapted for their guidance or entertainment. But not all. The editor says that the masculine element is essential to the right composition of a home, and, beginning in the second number, this element is represented by a series of "Talks about Photography," by Mr. Alexander Black. The contents of the first number comprise editorials, an illustrated description of "Some Old Virginia Homesteads," two stories, a charade, some poetry, practical articles on "Birds and their Care" and "Cheap Living in Cities," and departments of house-work, fancy-work, games, the nursery, the care of the aged, household health, fashions, window-gardening, and book notices. The third issue is a Christmas number, and its contents are adapted to the season. Christine Terhune Herrick and Grace Peckham, M. D., are associate editors, and among the other writers are Olive Thorne Miller, Catherine Owen, Lucy C. Lillie, Margaret E. Sangster, and Rose Terry Cooke. The paper and printing of the magazine are of excellent quality, and the illustrations are numerous and have a very pleasing effect.

Garden and Forest: a Journal of Horticulture, Landscape Art, and Forestry. Conducted by Prof. Charles S. Sargent. Published weekly. New York: The Garden and Forest Publishing Company. Price, 10 cents a number; $4 a year.

With its last number for 1888, "Garden and Forest" closes its first volume, which began with the issue for February 29th. This journal, at its first appearance, took rank as a thoroughly competent and progressive representative of the arts to which it is devoted, and this character has been ably maintained. A glance at the index of Volume I shows that an immense variety of plants has been described, and a large number of other subjects has been treated in the forty-four numbers that have already appeared. "Garden and Forest" is not a florists' and nurserymen's trade-journal, but, while giving the dealers in flowers and trees, and also the fruit-growers, much scientific information of value to them, it has an interest also for the botanist, and for him who has the arrangement of public or private grounds. The departments represented in each issue are: editorials, English correspondence, new or little-known plants (illustrated), cultural department, the forest, correspondence, recent publications, and notes. Other subjects which have been given a place from time to time are: horticultural exhibitions and conventions, entomology, and the management of public parks. Each number contains three or four illustrations, one being always a portrait of some unfamiliar but valuable plant. Among the writers for this journal besides the editor, who is Director of the Arnold Arboretum and Professor of Arboriculture in Harvard College, are W. G. Farlow, Sereno Watson, B. E. Fernow, C. G. Pringle, C. C. Abbott, and William Falconer in this country, and W. Watson, George Nicholson, and W. Goldring in England. It is seldom that a periodical appears which is so well deserving of a long and prosperous life as "Garden and Forest."

The most extended paper in No. 2, Vol. II, of the *Journal of Morphology*, is "On the Development of *Manicina Areolata*," by Henry V. Wilson, Fellow of the Johns Hopkins University. It is the result of study of these corals in the spring of 1887 at the marine laboratory of the university, which was then stationed on the island of New Providence, Bahamas, supplemented by investigations made at the biological laboratory in Baltimore. The text is illustrated with seven plates. R. W. Shufeldt, M. D., contributes two monographs: the first being "Further Studies on *Grammicolepis Brachiusculus*, Poey," a fish of which only one specimen is known to naturalists; and the other being "On the Affinities of *Aphriza Virgata*," the popular name of which is the surf-bird. Both these papers deal with the osteology of the subjects. The former is accompanied by fourteen woodcuts and the latter by a plate. "The Structure and Development of the Visual Area in the Trilobite, *Phacops Rana*, Green," is described by John M. Clarke, with a plate; and Prof. E. D. Cope has a paper in this number entitled "On the Relations of the Hyoid and Otic Elements of the Skeleton in the Batrachia," with three plates.

In *The Journal of Physiology*, Vol. IX, No. 4 (Cambridge, England, Scientific Instrument Company), J. S. Haldane, M. A., M. B., presents a brief account of investigations on "The Elimination of Aromatic Bodies in Fever." There is another brief paper by Vincent D. Harris, M. D., and Howard H. Tooth, M. D., "On the Relations of Micro-organisms to Pancreatic (Proteolytic) Digestion"; and a "Note on the Elasticity Curve of Animal Tissues," by Charles S. Roy, M. D., F. R. S., with a plate. The most extended paper in this number is "On the Nature of Fibrin-Ferment," by Prof. W. D. Halliburton, M. D., who states, as the principal result of his researches in this direction, that "the fibrin-ferment, whether it be prepared by Schmidt's or Gamgee's method, is a globulin derived from the disintegration of the white blood-corpuscles and identical with a proteid I have previously named cell-globulin, which is the principal proteid contained in the cells of lymphatic glands." This number contains also a communication on "Some Points in the Physiology of Gland

Nerves," by J. Rose Bradford, D. Sc. Nos. 5 and 6 form a double number, which contains three papers: "On Digestion in Hydra, with some Observations on the Structure of the Endoderm," by M. Greenwood, with two plates; "On the Phenomena of Inhibition in the Mammalian Heart," by Prof. John A. McWilliam, M. D., with two plates; and "On the Normal Duration and Significance of the 'Latent Period of Excitation' in Muscle-Contraction," by Prof. Gerald F. Yeo, M. D., with cuts of tracings.

Proceedings of the United States National Museum, Vol. X, 1887, consists of technical descriptions of fishes, birds, etc., illustrated with thirty-nine plates and a number of text-figures. Appended to the volume is a "Catalogue of the Contributions of the Section of Graphic Arts to the Ohio Valley Centennial Exposition, Cincinnati, 1888." These contributions represent processes of engraving and printing for pictorial purposes from the sixteenth century to our own time, wood-engraving in the United States, etching in the United States, and modern photo-mechanical processes.

The Report of the Entomologist, of the Department of Agriculture, Prof. *Charles V. Riley*, for 1887, is devoted chiefly to an article by L. O. Howard on the chinch-bug, giving a complete account of the species, and an article on the codling moth by the same writer. The use of the kerosene emulsion, the only recently devised remedy for the chinch-bug of any importance, is treated in some detail in the first article. Other papers accompanying the report relate to silk-culture, scale-insects, and other locally noxious species, apiculture, etc. The report contains eight plates, showing the insects treated of, methods of fumigation, and the Cattaneo mulberry-tree.

In *The Cat and its Diseases*, Dr. *E. M. Hale*, of Chicago, has published a useful and convenient paper on this animal of highly domestic habits and the treatment which it is entitled to receive. Brief accounts are given of the origin and history, traits, and varieties of the cat. Under the heading of "Health of Cats" are discussed their food, including grass, their drink, housing, and the care of their fur. Several diseases are described, and the special treatment that should be given for each.

The report on *Mineral Resources of the United States*, 1887, by *David T. Day* (United States Geological Survey, 50 cents), is the fifth of the series on this subject. It extends the information contained in the previous volumes to include the calendar year 1887. The statistical tables have been brought forward, but with this exception only such information as is supplementary to the previous volumes should be looked for. The principal statistics concerning the more important substances have already been published in special bulletins. From this report it appears that not only was the production of iron and steel in the United States very much larger in 1887 than in the previous year, but we consumed virtually all that we produced, besides many thousand tons of old iron worked over, and imported more than in any other year except 1880. For several years we have consumed more iron and steel than any of the great European countries. Our production of gold shows a decrease of about two million dollars from 1886, while silver shows an equal increase. During the greater part of the year the copper market was very dull, yet our production shows an advance over the highest previous figures. The output of lead went far ahead of the largest previous quantity. Zinc also shows an increased production. While there was practically no production of pure aluminum in 1887, the amount of aluminum bronze produced has risen from 4,000 or 5,000 pounds in 1885 to 144,764 pounds in 1887, and the amount of ferro-aluminum from 2,500 pounds in 1886 to 42,617 in 1887. The total production of all kinds of commercial coal shows a marked increase, owing partly to the near-by use of natural gas, stimulating coal to seek more distant markets, and partly to the advance in the iron manufacture. The restriction of the output of petroleum in the Pennsylvania and New York fields was compensated by the increase in the Ohio field, with some help from West Virginia and California. The consumption of natural gas can be got at only approximately. The amount of other fuel displaced by it, estimated at the value of less than five million dollars in 1885 and ten millions in 1886, had risen to over fifteen millions in 1887. The value of the precious stones produced in the

United States is not an important item, being estimated at only $88,600 in 1887. The production of salt shows a slight advance, while that of mineral waters appears to have been stationary.

The chemist who would profit by *A Correlation Theory of Chemical Action and Affinity*, by *Thomas Wright Hall*, M. D. (Remington & Co., London, 7*s.* 6*d.*), must first learn a new dialect, for the author's strange conceptions are made still harder to grasp by his eccentric language. We are not certain that the present generation is prepared to profit by this book, even if the language were as clear as the "Dayshine," whose influence the author rates above all other forces. "If you narrow and dwarf," says he, "the Photothermal Force to heat and light alone, or to cold and shade alone, or to the petty needs and feelings of Man, or to the ken of his workshops, of his pyrometers, thermometers, photometers, then, indeed, is the August Photothermal Force or Firemight shorn of its true and boundless majesty and value. Not so, however, if it dawn in Science that the sidereal and the planetary shine powers are the Giant Springs of the Firemight which in oscillatory static balance with each other in *actual* Ethero-molecular matter, and in free Ether evolve the Quintessential Form and Photothermality of the Earth—evolve the Dayshine and Nightshine and the Shapes and colored Loveliness of our Home, the Earth." The above sample will show the character of the book better than a long description.

Mr. *James E. Talmage's First Book of Nature* (The Contributor Company, Salt Lake City) is a little volume embodying a brief description of the animal, vegetable, and mineral kingdoms and the heavens. The doctrine of evolution is not referred to in its pages. The complexion of the book has been determined by the author's desire to show that "Nature is but another name for the will of God as expressed in his works." The volume is illustrated, and is adapted to the reading of young people.

Although relating largely to the election of 1888, *True or False Finance* (Putnam, 25 cents), in the "Questions of the Day Series," presents the subject of taxing imports on a basis which has a permanent interest—i. e., as a question of raising revenue. The author starts with the proposition that a true system of finance will enable a government to adjust its revenue to its expenditures without the slightest difficulty. He then shows how the growth of commerce has made former tariff exactions enormous at the present time, and gives the ways proposed by protectionists for getting rid of the surplus now in our treasury. The Democratic policy is next stated, the Mills Bill is described, and the effects it would have on the workman, the farmer, the wool-grower, and the country at large are told.

No. 10 of *Shoppell's Modern Houses* (Co-operative Building Plan Association, New York, 25 cents) has come to hand. It contains designs for twenty-one dwellings and a bank, giving in each case a perspective view, floor-plans, and a brief description. The cost of carrying out these designs is stated in each case, and ranges from $500 to $15,000. Some general advice on building is given and information concerning the plans, specifications, estimates, etc., which the "Association" is prepared to furnish to those about to build.

Miss Parloa's New Cook-Book (Estes & Lauriat) comes to us in the form of a large-paged pamphlet, crowded with recipes, briefly worded and in small type. A great variety of dishes is described in each of the divisions of soups, fish, meats, vegetables, pies and puddings, cake, dessert, etc. Miss Parloa's name is sufficient guarantee for the excellence of the book.

A Code of Morals, by *John S. Hittell* (The Bancroft Company), is a little didactic treatise, modeled after the manuals of Epictetus and Marcus Aurelius. "Standing on the shoulders of the eminent men who wrote those immortal books," says the author, "making use of their labors, and striving to appropriate the knowledge of our time and to put myself in harmony with its spirit, I have here tried to do for my age what they did for theirs." The manual consists of forty-five brief sections on separate topics, grouped in five chapters, viz., on individual duties, social, industrial, political, and religious duties.

Die Gegenwart (The Present) is a German monthly, twenty-four-page periodical, for the people, devoted to the discussion of questions of the times, entertainment, and instruction, published at Chicago by Th. G. Steinke. With the January number for 1889 it entered upon its second volume. Subscription price, $1 a year.

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Bartlett, John R., New York. Plans for an Auxiliary Supply of Pure Water, under Pressure, to the Cities of New York and Brooklyn. Pp. 117, with Plates and Maps.

Brinton, Daniel D., M. D., Philadelphia. The Ta ki: The Svastica and the Cross in America.

Brown, Harold P., New York. The Comparative Danger to Life of the Alternating and Continuous Electrical Currents.

Chavannes, Albert, Adair Creek, East Tenn. Vital Force and Magnetic Exchange. Pp 45.

Children's Aid Society of New York. Thirty-sixth Annual Report. Pp. 112.

Clarke, John M. Structure and Development of the Visual Area of the Trilobite *Phacops rana*, Green. Boston: Ginn & Co. Pp. 18, with Plates.

Conklin, Benjamin Y. English Grammar and Composition. New York, Boston, and Chicago: D. Appleton & Co. Pp. 296. 75 cents.

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Emery, Titus Salter. Inorganic Coal and Limestone in an Electro-Chemical World. Pp. 137.

Empire State Association of Deaf-Mutes. Proceedings of the Twelfth Convention, Rochester, August, 1888. Thomas J. Fox, New York, Secretary. Pp. 48.

Evermann, Barton W. Birds of Carroll County, Indiana. Pp. 30.

Eyerman, John. On the Mineralogy of the French Creek Mines in Pennsylvania. Pp. 4.

Fitch, Charles H., Denver, Col The Fallacy of Free Land. Pp. 16.—Womanhood Suffrage. Pp. 12.

Gill, John Systems of Education. Boston: D. C. Heath & Co. Pp. 312. $1.10.

Hall, G. Stanley, Editor "The American Journal of Psychology." Quarterly. November 1888. Baltimore: N. Murray. Pp. 192. $1.50. $5 a year.

"Harvard Law Review." Vol. II, No. 1. Pp. 44. 35 cents. $2.50 a year.

Hill, Robert T., University of Texas. Some Recent Aspects of Scientific Education. Pp 25.

Hinds, Prof. J. L. D., Lebanon, Tenn. Charles Darwin. Pp 15.

Hinrichs, Dr. Gustavus. Tornadoes and Derechos. Pp. 28.

Howard, J. M., D. D., Editor. "Cumberland Presbyterian Review." Quarterly. Vol 1, No. 1. Nashville, Tenn. Pp. 128. 75 cents. $2.50 a year.

Illinois, University of. Agricultural Experiment Station. Bulletin No. 3. Pp. 10.

Hunt, Mrs. Mary H. Scientific Temperance Instruction in Schools and Colleges. Pp. 60. Boston: W. S. Best.

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Langley, Samuel P. Report as Secretary of the Smithsonian Institution for 1887–'88. Washington: Government Printing-Office. Pp. 121.

Laux, James B., Greensburg, Pa. The Life Immortal (Poem). Pp. 12.

Lockhart, J. G. Ancient Spanish Ballads. New York: G. P. Putnam's Sons. Pp. 299.

M. M. "The Southern Whig." New York: Crichton & Co., 221 Fulton Street. Pp. 7.

Mac Auley, Clay. The Seminole Indians of Florida. Washington: Government Printing-Office. Pp. 64.

Maine, Henry Sumner. International Law. New York: Henry Holt & Co. Pp. 233.

Malone, J. S The Self: What is it? Louisville, Ky.: John P. Morton & Co. Pp. 1 8. 75 cents.

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Mendenhall, Prof. T. C., Terre Haute, Ind. On the Intensity of Earthquakes. Pp. 8.

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Packard, Alpheus S. On Certain Factors of Evolution. Pp. 14.

Palmer, Charles T. Artificial Persons (Corporations). Chicago: Open Court Publishing Company. Pp. 16.

Phythian, R. L. Report of the Superintendent of the United States Naval Observatory. Washington: Government Printing-Office. Pp. 24.—Charting the Sky. Pp. 4.

Platt, James. Business. New York: G. P. Putnam's Sons. Pp. 289.

Pohlman, Julius, Buffalo, N. Y. Cement Rock and Gypsum Deposits in Buffalo. Pp. 4.—The Life-History of Niagara. Pp. 17.

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Schultz, Carl H. Answer of Defendant in Suit of City of Carlsbad and Others *vs.* Carl H. Schultz. Pp. 11.

Seymour, Mary F. "The Business Woman's Journal." Bi-monthly. Vol. 1, No. 1. New York: 35 Park Row Pp. 32. 20 cents. $1 a year.

Shufeldt, R. W. On the Affinities of Aphriza Virgata. Pp. 32, with Plate.—Further Studies of Grammicolepis Brachiusculus, Poey. Pp. 24. Boston: Ginn & Co.—Notes on Horned Mammals, etc. Pp. 8.

Sluys, A. Manual Training in Elementary Schools for Boys. New York: Industrial Education Association. Pp. 37. 20 cents.

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Smith, W. H., Editor. "The Educator." Monthly. Vol. I, No. 1. Pp. 16. Buffalo, N. Y. $1 a year.

Spanhoofd, A. W., Editor. "Germania." A Fortnightly Journal for the Study of German. Manchester, N. H. Band I, Nummer 1. Pp. 16. 15 cents. $3 a year.

Stevens, C. A. Living Matter: Its Cycle of Growth and Decline in Animal Organisms. Norway Lake, Me: The Laboratory Company. Pp. 107.

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Von Klein, C. H., Dayton, Ohio. Address on Rhinology. Pp. 12.

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Young, Charles A. A Text-Book of General Astronomy. Boston: Ginn & Co. Pp 557. $2.40.

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POPULAR MISCELLANY.

M. Chevreul's New-Year's-Day.—M. Chevreul, who was a hundred and two years old on the 31st of August last, had a happy New-Year. According to an authentic account of his present daily life, given in "La Nature," he awakes at five o'clock in the morning, and is served a few minutes afterward with a warm broth, which he takes with a relish. While resting in bed he reads the papers, and then receives a few visits, particularly one from his *preparateur*, M. Arnaud. At eleven o'clock, still in bed, he takes a plentiful breakfast of soup, meat, and *café au lait*, with much bread and butter. At one he rises, dresses, and is ready to take the air for two hours. Conducted by his faithful coachman, Joseph, who has been in his service for twenty years, he often drives to the Monceau Park; but his favorite excursion is to the Eiffel Tower. Returning at five o'clock, he takes a glass of milk and goes to bed. He dines in bed at seven o'clock, with a good appetite, drinking nothing but water. After dinner, he sleeps soundly; and when M. Arnaud asks him in the morning, as he always does, if he has enjoyed a good night's rest, he replies that he has never had any other kind. M. Chevreul is living with his son, and enjoys the devoted and intelligent care of his old servant Denise, who has been with him for fifty years.

The Australasian Association.—The first meeting of the Australasian Association for the Advancement of Science was held at Sydney, beginning August 28th, under the presidency of Prof. Black. About eight hundred and fifty members were present, and one hundred and ten papers were sent in. One of the topics discussed in the presidential address was the place of chemistry in education. The accounts of the sectional meetings are scanty. We find mentioned in the Chemical Section, the papers of Mr. Dixon, on "The Formation of Coal," in which the different qualities of the mineral were ascribed to different kinds of vegetable matter of which it is composed; of Mr. Smith, on "Butterine," which was well spoken of; of Mr. Mingaye, on the "Discovery of Tellurium in Certain Bismuth Ores" in New South Wales; of Mr. Edgar Hall, on "Silver Smelting," etc., which was exceedingly well received; of Mr. W. Skey and Mr. Don on "Gold" in the Australian reefs; and of Mr. J. H. Maiden, on the "Chemistry of Indigenous Australian Products." The formation of this association was suggested in 1879, begun in 1884, and completed at this meeting, which was held in connection with the one hundredth anniversary of the foundation of the colony of New South Wales; and was most actively promoted by Prof. Liversidge. The scheme of its organization has been so arranged as to make it truly representative of all the Australian colonies. Each learned or scientific society may have one representative in the Council for every hundred of its members. The Presidents of the Royal Societies of the several colonies are among the vice-presidents. The presidents of sections were all selected from other colonies than New South Wales, while the secretaries were, of course, residents of the place of meeting, Sydney. It is understood that the meetings are to be held in rotation through the colonies, and the officers chosen accordingly. The meeting for 1889 is to be held in Melbourne, with Baron Sir Ferdinand von Müller as president; and the meeting for 1890 will be in New Zealand.

Habits of the Red Squirrel.—Dr. R. Bell, of the Canadian Geological Survey, says that over more than one half of its range, the chickaree, or red squirrel (*Sciurus Hudsonius*, Pennant), lives chiefly on the seeds of the black and the white spruce, and evidently thrives on this diet. "Their mode of obtaining a supply of cones is ingenious. The cones grow principally at the tops of the spruce-trees, and the largest and finest are always to be found there. The chickaree selects a tree which, either from the steepness and density of its upper part or from its leaning to one side, makes it certain that the cones, if detached, will fall to the ground; then he cuts off the heavily laden twigs and lets them drop. This is done with an impatient rapidity. Should a person be sitting quietly under a tree while one of these busy little creatures is at work at the top, he will see the bunches of cones come tumbling down in such quick succession that he might suppose half a dozen squirrels were at work instead of only one industrious little fellow. These bunches seldom lodge in the branches below, but should the squirrel on his way down (after having cut off a satisfactory supply) notice one of them arrested in a hopeful position toward the extremity of a bough, he will sometimes run out and give it a second send-off. In climbing tall spruce-trees for observations of the surrounding country, I have often noticed bunches of cones lodged where, if started off a second time, they would be certain to catch again in the thick branches before reaching the ground. The squirrels seem to understand the situation perfectly, and they leave such bunches to their fate, probably arguing that it would be easier for them to cut off fresh ones than to trouble themselves further about property lost beyond hope of profitable recovery—a piece of wisdom which the most successful business men have also learned to follow. The chickaree, having thrown down a sufficient stock for a few days' use, proceeds to carry them, as required, to his favorite feeding-place near by. I have occasionally noticed a squirrel feeding with a fresh cone lying beside the one he was actually dining off, as if it were waiting to be attacked the moment he got through with the first. They peel off the scales in succession, and nibble out the seeds with great rapidity. They leave their stock lying about under the tree, and only carry off one or two cones at a time. A little drying causes the scales to gape, and so facilitates the opening process."

Protection of Piles against the Teredo.—A series of experiments has been made in San Francisco Harbor on the best method of protecting piles against the attacks of the teredo. Five methods of preparation were tried, viz.: Jacketing with sewer pipe and filling the space between pile and pipe with concrete of sand, gravel, and Portland cement; covering with asphaltum and wire cloth; washing, in four coats, with a secret marine cement that contained an extremely poisonous substance of great efficiency; washing with Portland cement and other secret ingredients; and covering with burlap and a paste of naphtha, carbon bisulphide, limestone, kaolin, sawdust, and sulphur. The treated piles were all barked. Besides these, some piles in the natural condition, untreated but covered with their bark, were driven down. Of a number pulled for examination after about four years, all of the treated piles except those prepared by the first method were hopelessly riddled by the teredo, and only one was strong enough to be removed without breaking, while the untreated ones were only slightly attacked, and were practically as sound as ever. The coatings applied by the various experimenters, depending upon their adhesion to the pile, utterly failed to afford even the protection given by the bark. The result agrees with experiments made in other places. Inclosing with drain-pipes and packing with concrete affords adequate protection, but the expense of the method—thirty dollars a pile—makes it unavailable.

Bulgarian Wines.—It is only of recent years that the cultivation and production of the vine have attained any considerable proportions in Bulgaria. Formerly it was looked upon as a most unimportant industry. Now there are about 172,000 acres of land under vine-cultivation in north and south Bulgaria. The yield of wine per acre varies between 250 and 350 gallons, two thirds of which is red wine and the remainder white. The wine in some vineyards is said not to be inferior to the best natural wines of other European countries. In 1886 some 140,000 gallons of wines were exported from southern Bulgaria to the south of France. There they were manipulated and sold as the products of the country. The phylloxera made its appearance a few years ago, but stringent measures were at once taken to stamp it out, and very strict regulations are enforced to prevent its return.

The Chemistry of an Egg-Shell.—The shell proper of an egg is made up mostly of earthy materials. The proportions vary according to the food of the bird, but ninety to ninety-seven per cent is carbonate of lime. The remainder is composed of from two to five per cent of animal matter and from one to five per cent of phosphate of lime and magnesia. Now, Mr. P. L. Simmonds asks, where does the hen procure the carbonate of lime with which to form the shell? If we confine fowls in a room, and feed them with any of the cereal grains, excluding all sand, dust, or earthy matter, they will go on for a time and lay eggs, each one having a perfect shell, made up of the same calcareous elements. Vauquelin shut up a hen for ten days, and fed her exclusively upon oats, of which she consumed 7,474 grains in weight. During this time four eggs were laid, the shells of which weighed nearly 409 grains; of this amount 276 grains were carbonate of lime, 17½ grains phosphate of lime, and 10 grains gluten. But there is only a little carbonate of lime in oats, and whence could this 409 grains of the rocky material have been derived? The answer to this question opens up some of the most curious and wonderful facts connected with animal chemistry. The body of a bird, like that of a man, is but a piece of chemical apparatus, made capable of transforming hard and fixed substances into others of a very unlike nature. In oats there is contained phosphate of lime, with an abundance of silica, and the stomach and assimilating organs of the bird are made capable of decomposing the lime-salt and forming with the silica a silicate of lime. This new body is itself made to undergo decomposition, and the base is combined with carbonic acid, forming carbonate of lime. The carbonic acid is probably derived from the atmosphere, or more directly perhaps from the blood. These chemical changes among hard inorganic bodies are certainly wonderful when we reflect that they are brought about in the delicate organs of a comparatively feeble bird, under the influence of animal heat and the vital forces. They embrace a series of decomposing and recomposing operations which it is difficult to imitate in the laboratory.

Fresh-Water Sponges.—The fresh-water sponges, according to Mr. Edward Pott's monograph, resemble in constitution and general appearance many of the sponges of a marine habitat, with the addition that they have gemmules or "seed-like bodies," which marine sponges have not. They are green, but may be distinguished from mosses and *Confervæ* by the difference between smooth, slender threads and leaves; by the presence of efferent or discharging apertures; and, with a lens, by their spicules — to which finding the spherical gemmules adds further confirmation. The green color varies according to the light, and may, in dark places, or dark parts of the sponge, be faded into nearly white, gray, or cream color; but some species are never green in the sunlight. These organisms have occasionally been discovered growing in water unfit for domestic uses; but as a rule they prefer pure water, and in the author's experience the finest specimens have always been found where they were subjected to the most rapid currents. "The lower side of large, loose stones at the 'riffs' or shallow places in streams; the rocks amid the foaming water at the foot of a mill-dam fall; the timbers of a sluice-way, the casing of a turbine water-wheel, or the walls of a 'tail-race' beneath an old mill—in all these places they have been found in great abundance and of a very lusty growth. Of all discouraging situations it is almost hopeless to look for them in shallow water having a mud bottom. . . . In any body of water liable to be charged with sedimentary material, the principle of natural selection favors those growing on the lower side of their bases of support, which protect them from the intrusion of the heavier particles. For that reason perpendicular and water-logged or floating timbers, submerged stumps of trees, and branches drooping into the water from trees or bushes along the banks, are favorite locations. They do not disdain more temporary support, such as weeds and water-grasses. . . . Through the clear water of our Northern lakes we may often see them lying in slender lines upon the leaves of submerged weeds, or in beautiful, cushion-like masses upon the stones or gravel." The best season for collecting them is from July till late in November.

Geological Floras. — M. de Saporta's views on the origin of our forest-groupings were substantially concurred in by Prof. W. Boyd Dawkins, in his vice-presidential address before the Geological Section of the British Association. Having referred to the characteristic features of the earlier floras, much as M. de Saporta has done, and to the antiquity of the gingko (which has descended from the Carboniferous age), he says: "In North America the flora of the Dakota series so closely resembles the Miocene of Switzerland that Dr. Heer had no hesitation in assigning it in the first instance to the Miocene age. It consists of about one hundred species, of which about one half are closely allied to those now living in the forests of North America—sassafras, tulip, plane, willow, oak, poplar, maple, birch, together with sequoia, the ancestor of the giant redwood of California. The first palms appear also in both continents at this place in the geological record. In the Tertiary period there is an unbroken sequence in the floras, as Mr. Starkie Gairdner has proved, when they are traced over many latitudes, and most of the types still survive at the present day, but slightly altered. If, however, Tertiary floras of different ages are met with in one area, considerable differences are to be seen, due to progressive alterations in the climate and altered distribution of the land. As the temperature of the northern hemisphere became lowered, the tropical forests were pushed nearer and nearer to the equator, and were replaced by plants of colder habits from the northern regions, until, in the Pleistocene age, the arctic plants were forced far to the south of their present habitat. In consequence of this, Mr. Gairdner concludes that 'it is useless to seek in the arctic regions for Eocene floras as we know them in our latitudes, for during the Tertiary period the climatic condition of the earth did not permit their growth there. Arctic fossil floras of temperate and, therefore, Miocene aspect are in all probability of Eocene age, and what has been recognized in them as a newer or Miocene *facies* is due to their having been first studied in Europe in latitudes which only became fit for them in Miocene times. When stratigraphical evidence is absent or inconclusive, this unexpected persistence of plant-types or species throughout the Tertiaries should be remembered, and the degrees of latitude in which they are found should be well considered before conclusions are published respecting their relative age.' This view is consistent with that held by the leaders in botany—Hooker, Dyer, Saporta, Dawson, and Asa Gray—that the north polar region is the center of dispersal, from which the dicotyledons spread over the northern hemisphere."

Science and Trade-Routes.—In the first part of his presidential address before the Geographical Section of the British Association, Colonel Sir C. W. Wilson showed, by numerous historical references, how the trade-routes of the world are and have always been governed by physiographical conditions, and by accidents of war and human operations, which, making one route inconvenient, have compelled the opening of another. To cope with these conditions, and find and possess the best route, is one of the functions of the scientific geographer. The discovery of the Cape route was no mere accident, but the result of scientific training, deep study, careful preparation, and indomitable perseverance. Prince Henry, having determined to find a direct route to India, invited the most eminent men of science to instruct a number of young men who were educated under his own eye, and in a few years he made the Portuguese the most scientific navigators in Europe. The voyage of Vasco da Gama, with its grand commercial results, followed. For a correct determination of the lines which the shortened trade-routes and great maritime canals we are seeking to locate should follow, a sound knowledge of geography and the physical condition of the earth is necessary; and instruction in this direction should form an important feature in any educational course of commercial geography. The great problem of the future is the inland carrying trade, and one of the immediate commercial questions of the day is, Who is to supply the interiors of the great continents of Asia and Africa, and other large areas not open to direct sea traffic? It is not altogether impossible to foresee the lines which inland trade must follow, and the places which must become centers, or to map out the districts which will be dependent on those places. These questions as to a part of Central Asia may have been partly solved by a voyage which Mr Wiggins made last year. Acting upon a conviction which he had reached by a strict method of induction, that the Gulf Stream passed through the straits into the Kara Sea, and, acting with the floods of the Obi and Yenisei, would free that sea from ice and keep it open for navigation during a part of each year, he sailed to Yeniseisk, some two thousand miles up the Yenisei, within a few hundred versts of the Chinese frontier, and landed his goods there. The science of commercial geography is not confined to a knowledge of the localities in which those products of the earth that have a commercial value are to be found, and of the best markets for them. Its higher aims are to divine, by a combination of historical retrospect and scientific foresight, the channels through which commerce will flow in the future, and the points at which new centers of trade must arise in obedience to known laws.

The Underground Waters of England.—In a paper on the underground waters in the permeable formations of England, Mr. E. E. De Rance said that the remarkable drought that that country experienced during 1887 had brought out in strong relief the advantage of public water-supplies being drawn from underground sources, where the rainfall of wet periods is not only stored in the sandstone rocks, but is delivered filtered from organic impurity and at a constant equable temperature. Notwithstanding the unprecedented period of dry weather, the public wells of Liverpool, Birkenhead, Birmingham, Southport, Nottingham, South Staffordshire, and the Staffordshire pottery-works gave their daily supply undiminished, while the gravitation works of the Manchester corporation and the whole of the east Lancashire towns were on short supply, and in some instances failed altogether. The levels taken at a well at Bocking, in Essex, for several years, showed that the water-level was uplifted by the Essex earthquake of April 22, 1884. This acquired level was gradually diminishing, at a rate which would bring back the original level by August, 1888.

Chinese Names.—The Chinaman bears his father's name; the woman, on marrying, takes her husband's name and adds her father's to it. Thus, when Miss Wang marries Mr. Ly, while she might usually be called Mrs. Ly, she must in formal acts sign herself Ly-Wang. People of the lower classes have names the character of which varies in different places. In Pekin, a number answers the purpose, and we have for Mr. Chang's sons, the elder Chang, second Chang, third Chang, etc. At Canton they add *ah* and a surname, and we have Chang-ah-brave and Chang ah-honest, if it is a man; Chang-ah-silver, Chang-ah-pearl, if it is a woman. In Fuhkien they double the character and give Chang-stone-stone, Chang-great-great, etc. When a youth goes to school, his teacher selects a name for him consisting of two characters, such as "Five Stars," "Long Life," or some other fantastic designation; but only the teacher and the other pupils can use this surname. As soon as a young man is married, his own friends or the friends of his wife's family give him a name which is used only by members of the agnatic family; but this custom is not very faithfully observed. When a person presents himself for the public examinations, or is seeking a position, he usually chooses a name composed of two characters, which becomes the only name under which he is officially known. A person who has never been to school, is not married, and never obtains an official position, can only have his family name and his regular surname, according to the custom of the province. The school and marriage names being of little importance, persons may be classed, generally, according to their names, as official and non-official. Those of the latter class have only their name and surname, unless they have acquired a nickname, like Chang-dog's-eye, Wang the gimlet, etc. Persons of the official class have three names: the family name; the official name, used only officially; and the private name, used by friends. On the death of an official personage, the emperor will, if he thinks best, confer upon him a posthumous name.

Improved Gas Heating Appliances.—A new gas heating appliance has been devised by Mr. Thomas Fletcher, F. C. S., of Warrington, England, who, in exhibiting it at Liverpool, fused a large hole in a plate of quarter-inch-thick wrought-iron in a few seconds, without preparation, and with apparatus which could be carried by a man up a ladder and used in any position. There is, therefore, no longer such a thing as a burglar-proof safe, for with this invention it is simply a question of minutes to fuse a hole large enough for a man to enter in any wrought-iron or steel door in existence. The professional burglar is always ready to utilize the latest applications of science, and may be expected to take this apparatus in hand. In fact, Mr. Fletcher's furnaces, designed to assist in chemical research, are used by receivers of stolen goods to reduce plate and jewelry to ingots. The form of this blow-pipe which Mr. Fletcher exhibited was noisy in action, but he stated that burglars would probably succeed in making it silent. A serious obstacle to their doing this, however, is that the machinery necessary for producing the noiseless form is both costly and large. The matter is one to which bankers and safe-makers should give their attention.

Forestry in Switzerland.—The present forestry law of Switzerland was enacted in 1876, and is applied to the mountain districts and the hills on the plains, covering about 60 per cent of the country, of which 15·8 per cent is forest-land. The rights of private owners are not affected except where their woods are "protecting" woods, or might have an influence on the climate, avalanches, land-slips, etc. All woods under official supervision have to be demarkated, clearings planted afresh, and new forests created where necessary, the Government bearing a just share of the expense. All servitudes or easements in "protecting" woods were to be redeemed in ten years, and no new ones were allowed to be created. Anything that might endanger the utility of the forests was forbidden. Cattle were not allowed to graze, and leaves could not be collected, except in fixed spots. A two months' course of education is prescribed to be given to each student of forestry by the canton to entitle it to the federal subsidy. It includes forest surveying and measurement in detail; road-making, and safeguards against avalanches; study of the different kinds of timber and of noxious plants; elementary knowledge of soils and of their component parts; fundamental notions of the laws of climate and meteorology; cultivation and care of forests; and book-keeping and other general branches of instruction valuable for under-foresters. These provisions were put in operation very slowly, waiting the compliance of the cantons; and even yet each canton possesses in a measure its own scheme of forestry organization.

An Aged Spider.—In the summer of 1887 an American tarantula died, which had been in the possession of Mr. H. C. McCook over five years, and which he estimates was at least seven and perhaps eight years old. This spider, which Mr. McCook had named "Leidy," after Dr. Joseph Leidy, from whom he had received it, thus attained the distinction of having reached the greatest age of any spider known to science. The fragments of a cast skin were found near the carcass of the tarantula, indicating that it had died shortly after molting. "Leidy" had shed its skin several times during its confinement. Mr. McCook has had best success in keeping large spiders alive by feeding them a generous supply of living insects during the summer and early autumn, and withholding food almost entirely during the remainder of the year. Spiders require water quite as much as other animals. They do not become torpid in winter, if kept in a room heated to a moderate temperature. "Leidy" kept a rug-like web spread on the ground in the box which it inhabited, and when this became soiled, by earth or food *débris*, it was soon overspread with a clean layer. In this way a thick mass of intermingled soil and silk was formed. The only effort at nest-building which it made was a rude burrow against the side of the box. This burrow was entirely destitute of silken lining, although occasionally the opening would be overspun with a thin sheet.

Origin of Archæan Graphite.—In a paper at the British Association on the origin of graphite in the archæan rocks, the Rev. A. Irving points out that the occurrence of carbon in late rocks as the result of plant-life is no argument to prove that the graphite of the archæan is of similar origin. Indeed, conditions were then so different that this mode of origin is extremely unlikely. Elementary carbon is produced in three ways: in pig-iron, by reduction of carbonic acid by alkali metals, and by contact action of heated surfaces on hydrocarbons. As hydrocarbons exist in the heads of comets, some method of origin like the last is far more probable than that the graphite should be phytogenic. The author thought that Möbius's investigations disproved the organic origin of eozoön; the iron oxides of the American archæan would come from the combustion of iron vapor in oxygen, while the unfossiliferous limestones of the archæan can be explained on purely chemical and physical principles.

The Country Schools of New York.—The State Superintendent of Public Instruction of New York, in his last report, draws an unpleasant picture of the condition of the rural schools. In them, he says, "the work done depends almost exclusively upon the character and capability of the teacher. There is no 'system' to fall back upon, no machine which will turn out passable work, whether or no. If the teacher is discerning and bright and enthusiastic, results will frequently be attained which surpass any accomplished in the great schools; if indifferent, the results are of no consequence. . . . All teachers are entitled to consideration, for their work is trying and exacting; but this is more strikingly so in the cross-roads districts than elsewhere. Their pay is small. . . . Their work is not confined to a single grade; they must meet the requirements of all grades and all classes. They must lay out their own course of study, if they have any. Text-books are frequently antiquated; there is no uniformity, even in the same school, and frequently not in the same class, and the teacher finds it impossible to work improvement. The school is very likely maintained only twenty-eight weeks in the year, just long enough to share in the public moneys. Attendance is irregular. Trustees drive hard bargains, for the number of young persons who want the place is very large. Continual change in the teachers is the order of the day. The time of employment is but for a single term, and frequently the trustee undertakes to make it by the day or the week, in order that he may be free to effect a change at any time, or that he may withhold pay, in violation of the spirit and intent of the statute, for the week occupied in attendance upon a teachers' institute. Supervision amounts to little or nothing, for distances are great, during a good part of the year roads are impassable, and it is physically impossible for the commissioner, with generally more than one hundred schools under his charge, to visit each very frequently."

The Energy in an Earthquake.—After explaining, in the American Association, the impossibility of calculating the intensity of an earthquake more than approximately, Prof. T. C. Mendenhall applied a formula to determine the energy involved in the Japanese earthquake of January 15, 1887, which disturbed over 30,000 square miles of territory. He said: "Assuming a mass of 150 pounds per cubic feet, and taking a cubic mile as the volume to be considered, I find that to put it in vibration required the expenditure of 2,500,000,000 pounds of energy. Assuming an area of 100 miles square, with a mean depth of one mile, was thus in vibration at any one instant of time—which is not improbable, considering the known rate of transmission and the long duration of the earthquake—the amount of energy thus represented would be $25 \times 10 \cdot 12$ foot-pounds. This energy might be generated by the fall, under the action of gravity, of a cube of rock 1,000 feet on each edge, the mass of which would be 75,000,000 tons, through a vertical distance of 166 feet." Also, assuming certain magnitudes, "I find the energy of a cubic mile of the Charleston earthquake, taken near enough to the epicentrum to be disturbed, as above assumed, to be equal to 24,000,000,000 foot-pounds. The speed of transmission of this disturbance has been pretty well determined by Newcomb and Sutton to be approximately three miles per second, so that a cubic mile would be disturbed in one third of a second. To do this would require 130,000,000 horse-power. Assuming that an area about the epicentrum 100 miles square was thus disturbed, the energy would be that of 24×10^{13} foot-pounds, and the rate of its expenditure would be that of 1,300,000,000,000 horse-power."

Volcanic Explosion in Japan.—The district of Hibara Mura in Japan was visited on July 15th with a volcanic outburst of most singular character, which may be compared for violence with the recent catastrophes of Krakatoa and the Tarawera district of New Zealand. The whole of Mount Baudai, a peak nearly five thousand feet high, one hundred and fifty miles north of Tokio, was blown up, just as a steam-boiler might be, by the explosion of the vapors accumulated in the recesses beneath it. A number of villages were ingulfed, with all their inhabitants, estimated at about five hundred. The region was inundated by torrents of mud; and showers of dust, which was red at first and afterward turned gray, fell over a wide extent of country. The catastrophe, according to the accounts of witnesses who survived it, was marked with the accompaniments of fearful earth tremors, detonations which were said to sound like the firing off of all the artillery in the world at once, and a total darkening of the air for several hours. At one point a river was dammed up by the flow of mud, so as to form a considerable lake. The scene of the catastrophe was visited soon after the event by a scientific commission appointed by the Government, whose report has been published by Mr. W. K. Burton, of the Imperial University. In the view of this commission, the phenomenon differed from usual volcanic eruptions in that it left no traces of fire or lava. It was simply a violent explosion of steam. That the mountain was underlain by beds of hot water has always been indicated by the existence of hot springs on its slopes. The explosion carried off all the middle part of the mountain, including the central peak; it took a sidewise rather than a vertical direction, and scattered its *débris* to a depth of from three to thirty metres, and in one or two instances three hundred metres, over an extent of about sixty square kilometres. A remarkable feature of this disbursement is the steepness of the piles of matter in some places.

Sacred Trees of Japan.—Not the least engrossing element in researches into the flora of Japan is encountered in the traces of tree-worship here and there to be detected. In Shinti the *hi-no-ki*, the sun or fire tree (*Chamæcyparis obtusa*), is the sacred tree of predilection; the temples being constructed exclusively of this wood, even to the tiles and nails, or pegs; and from time immemorial the sacrificial fires have been kindled with drills made of hi-wood—whence perhaps its name. At the great bonzeries of Nikko, or sun-splendor, so named in the ninth century, the shrines of the Shoguns are surrounded by sugi-trees, the Japan cedars (*Cryptomeria Japonica*), which measure twenty feet in girth, and run to one hundred and twenty feet in height, contributing not a little to the force of the Japanese saying, "If you haven't seen Nikko, you mustn't say marvelous." The *shii* oak, or *Quercus cuspidata*, is also chosen for the environs of temples, perhaps because of its dense foliage, and quantities of its acorns are eaten at religious feasts. The beauteous *icho*, the *Gingko biloba* or *Salisburia adiantifolia*—also called the maidenhair-tree, from the resemblance of its leaves to the fern of that name—is also a sacred favorite. One at the foot of the staircase of the great temple at Kamakura measures twenty feet round. The Japanese consumed the almonds of this tree at religious festivals. And in northern Japan, wherever Shinto prevails, there are hallowed trees encircled with a rice-straw rope which bears tassels at intervals. The Japanese are in the habit of driving nails into the *rotesu* or *Cycas revoluta*, which yields the Japanese sago. This, they say, at the present day, is to push on vegetation; but your thoroughgoing comparative religionist is bound to detect in this survival the similar *piaculum* of the early Latins, records of which can be traced to the four hundred and twenty-third year of Rome. It is also common among the negroes of the Guinea coast and in Persia. The idea was to drive the prayer into the body of the idol, the god, the sacrosanct and worshiped tree; and a form of the practice survives in Brittany, where saints' statues have replaced primitive idols, and women's pins do duty for nails. About six miles west of Tokio, at Habashi, is the stump of an old ye-tree (*Celtis Willdenowiana*), so covered with *ex-votos* that its fame must be surpassing. Morsels of its decayed wood are sold to those who have grown weary of their loves. The force of the remedy lies in the application of it. The tinder is boiled, the damsel is got to drink of the charm unawares, and immediately she goes her ways, and leaves her charmer to sing "Joy go with her!" The bunches of spindles which grow on the great bosses or tumors of the *shiraga-matsu* (*Pinus Thunbergii*) are still revered as the nests or lairs of the *Ten-gu*, or heavenly dog, which inhabits mountains or lonely spots, has a long snout, two claws on each foot and hand, and a pair of wings.

Protective Charms.—Charms against almost any of the ills and dangers of life can be obtained in Burmah from the Buddhist priests, for a trifling consideration. One of these Wise Men will furnish a charm warranted to protect the wearer against being shot, for five or six rupees (between two and three dollars). One of these charms, obtained by an English officer, consisted of a tiny figure of Gaudama, in a sitting posture, not much exceeding a large pea in size, carved in ivory. In order to become proof against sword-wounds, a medicine made by the priest must be eaten. A specimen of this medicine resembled in appearance and odor dried leaves or bark finely powdered. Charms for other purposes consist of curious devices tattooed on various parts of the breast and shoulders; also of bits of ivory, silver, lead, etc., inscribed with magic spells, inserted under the skin. The Burman's faith in these charms is very deep-rooted, and in spite of frequent and painful proofs of their fallibility he does not seem to lose confidence in their magical properties. The injured man himself is generally the first to find an excuse for the failure of his talisman to protect him. Holders of gun-charms assert confidently that a gun fired at them will not go off, or will burst, but their faith is not so strong that they will consent to an experimental test.

Dr. Nansen's Greenland Expedition.—Dr. Frithiof Nansen has successfully accomplished the experiment which we described several months ago as about to be undertaken, of crossing Greenland from the eastern to the western side, and arrived at Godthaab on the 3d of October last. The party had some difficulty, owing to a southerly drift in which they were caught, in making a landing on the eastern coast as far north as they desired, but finally started to cross the inland ice from Umiavik, latitude 64° 30′, on the 15th of August. A course was at first set toward the northwest for Christianshaab, in Disco Bay; but much time being lost through severe northerly snow-storms, Dr. Nansen was compelled to turn to the westward for the nearer settlement of Godthaab. The western coast was reached after forty-six days' traveling, the distance from the point of departure being 280 geographical miles. For several weeks the explorers were at an altitude of more than 9,000 feet above sea-level, and suffered from snow-storms and loose snow, and a temperature of between 40° and 50° below freezing. As the last Danish ship of the season was not able to wait for them to be embarked upon it, the party will have to spend the winter in Godthaab.

Longevity of Professional Men.—The comparative longevity of professional men may be accounted for by reference to the exceptionally favorable conditions under which they exist. While the man who is in trade is tormented by anxiety over the uncertainties of the morrow, and the man who has made a fortune and retired is, unless he has cultivated a hobby, a prey to inanition, and liable to feel that he has no longer a welcome place in the world, the professional man of fifty has learned what he can do, and has adjusted himself to a career for which he is fitted. If he is making a fortune, his life is full of interest and brings little trouble or anxiety to himself. It is not his own case that the lawyer pleads, the physician combats, and the parson arraigns. If he is only moderately successful, his earnings, though small, are safe, and he may hope that his future will be as happy as his past. His occupation, meanwhile, brings him consideration and intelligent surroundings, and his life is fairly and pleasantly varied. These things all contribute to length of life.

NOTES.

The seventh annual meeting of the American Forestry Congress was held at Atlanta, Ga., December 5, 6, and 7, 1888. Papers and addresses on various subjects pertinent to forestry in America were given. The Congress has for its object the creation of a public sentiment in favor of a more rational treatment of our forest resources. It is proposed to raise a fund of ten thousand dollars for carrying on the work of the Congress, by creating life-memberships of one hundred dollars each. The management of the principal fund is to be in the hands of the subscribers to it, who will be known as patrons.

The programme for the second triennial session of the International Congress of Hydrology and Climatology, which is to be held in Paris in October, 1889, includes questions upon scientific hydrology, medical hydrology, and climatology. The membership fee is twelve francs.

According to Mr. Thomas T. P. Bruce Warren, the better descriptions of India-rubber, which are obtained from Brazil and Central America, are now so eagerly sought after for the markets of the United States and Germany that the British no longer have the monopoly of the industry. Yankees are so frequently at Pará that they have virtually the run of the market for the raw article there, so that British customers have often to take what would not pass muster for them.

Dr. Ludwig Wolf relates that while the natives of Africa usually meet the white man with suspicion and hostility, the Baluba people at once showed his party a blind, child-like confidence. They greeted them as former deceased chiefs and relatives of their king Kalamba Mukenge, by whose names they always called them. This was in pursuance of their belief that all distinguished warriors and chiefs will return to them metamorphosed after death.

Mr. Proctor left the manuscript of his "Old and New Astronomy" in a more advanced state than was feared. Its completion has been undertaken by Mr. A. C. Ranyard, who was for some time Secretary of the Royal Astronomical Society.

Arsenic having been recommended by Dr. Tommasi Crudelli as a substance that will efficiently augment the mean resistance of the human organism to the malarious ferment, Dr. Ricchi, medical supervisor of Italian railways, has adopted as a tonic food-preparation, to aid the preventive virtue of the arsenic, the impalpable soluble powder, made from the "sterilized" and desiccated blood of calves, which is known in commerce as "trefusia." Dr. Tommasi Crudelli approves the preparation, as being adapted to the condition of systems which are not susceptible of protection by the arsenical treatment alone. The same physician recommends decoction of lemon as a prophylactic or remedy in cases in which arsenic and quinine have failed.

Sudden deaths are most frequent, according to "The Lancet," when the conditions of life change suddenly, or are especially liable to change—and this without necessary reference to whether the change effected be relatively for the better or for the worse; for the change may be so rapidly effected, in either direction, as to throw upon the circulatory and respiratory functions a strain which the organs are not able to bear. In this way, persons with unsound or weak hearts or weak arteries die suddenly under rapid changes, although, if there were no special strain consequent on the change, it would in itself prove advantageous to them. It may be accepted that sudden deaths are especially likely to occur at periods of seasonal change, and at times when rapid variations of temperature are taking place.

Prof. H. J. Mackinder, Reader of Geography at the University of Oxford, expresses the opinion that the best preliminary training for a geographical specialist is a sound grounding in general science, and, superadded to this, an elementary knowledge of history. He has found by experience that it is exceedingly hard to give the necessary scientific knowledge to a historian.

Prof. Mackinder's courses in geography at Oxford for 1888–'89 will include lectures on "The Physical Geography of the Continents"; "The Geography of the British Isles, with Especial Reference to History"; and "The Historical Geography of North America." To these will be added lectures by Prof. Freeman on the "Historical Geography of Europe," and by the Reader in Indian History on "The Geography of India." Besides his duties at the university proper, Prof. Mackinder last year gave one hundred and two extension lectures on geography and physiography at ten towns.

The operation of transplanting a part of a nerve from a rabbit to a man has been successfully performed in Vienna, upon Prof. von Fleischl, of the university. The professor had lost his thumb and incurred neurotoma, and was suffering much pain. A piece, six centimetres long, was taken from the great nerve of a rabbit's thigh so as to include the natural bifurcation of the main trunk. It was secured to the stump of the nerve in the man's arm, and the ends of the branches to the nerve terminations that remained in the fingers, so as to restore the interrupted communication. All had gone well at the end of two months.

An "authorized" biography of the late Sir William Siemens has been prepared by Dr. William Pole, of the Society of Civil Engineers, and will soon be published in London.

Mr. Proctor's "Knowledge" will be carried on in future by W. H. Allen & Co., London, as an illustrated magazine, with more space devoted to physics, biology, etc., and with controversial articles on theological and allied questions excluded.

A new mole-like mammal, found in South Australia, is described by E. C. Stirling, of the university at Adelaide. It is a ground-burrowing animal, outwardly somewhat like the Cape mole, but differing from it in many respects. It is about five inches long, has no visible eyes, but a small pigment spot to be seen on reflecting the skin, where the eye should be; no external ears, but the ear-openings distinct and covered with fur; the fore-limbs short, resembling those of the mole, with the hands folded so that only two of the nails are visible in the natural position; and the hinder limbs also short, with the soles turned outward. The animal had never been seen by any of the aborigines, except by one old woman once.

A statue of Ampère was unveiled at Lyons, his native place, October 9th. The President of the French Republic attended the ceremony, and M. Cornu, of the Academy of Sciences, delivered the address.

The Copley medal of the Royal Society for 1888 was presented to Prof. Huxley, for his investigations into the morphology and histology of vertebrate and invertebrate animals, and his services to biological science generally; the Rumford medal to Prof. Tacchini, for his researches in solar physics; and the Davy medal to Mr. Crookes, for his researches on the electric discharge in high vacua. Royal medals were awarded to Baron Ferdinand von Mueller, the Australian botanist, and to Prof. Osborne Reynolds, of Owens College, for researches in mathematical and experimental physics.

M. Marambet reports that of 3,000 convicts in France, examined with respect to their habits of drunkenness or temperance, 79 per cent of vagabonds, from 50 to 57 per cent of assassins and incendiaries, 53 per cent of offenders against morals, 71 per cent of thieves, sharpers, etc., 88 per cent of offenders against the person, and 77 per cent of offenders against property, were drunkards. Drunkards are nearly as numerous among youths under twenty as among adults. The largest numbers of drunkards came from regions where spirits are most largely consumed.

An elaborate work on "The Viking Age," by M. de Chaillu, is soon to be published. It will present the early history, manners, and customs of the ancestors of the English-speaking nations, illustrated from the antiquities discovered in mounds, cairns, and bogs, as well as from the ancient Sagas and Eddas, with more than one thousand pictures.

Mexico affords a curious example of the demoralization which irrational tariffs work. To prevent bribery, the law imposes a system of fines and forfeitures of which the officers detecting irregularities are entitled to half. Foreign shippers rarely escape fines on their first consignments to Mexican ports, because, unless they are experts, or consult experts, they are very sure to have some flaw in their papers which the sharpened eye of the customs detective can fix upon as a pretext for levying a fine. The absence of a consular invoice is equivalent to the infliction of double duties, and this is often equivalent to confiscation. "Insufficient declaration" is punished by fines rising from ten to one hundred per cent on the duties, according to the nature of the offense.

The Indian system of weights and measures is described as being exceedingly confusing, because of the numerous different designations of the standards, and because the same designation may be applied to different standards, according as the articles differ, or as the transactions are held at different places. A maund of barley is not the same as a maund of indigo or of cotton, and a Bombay maund is different from a Calcutta maund. A seer is 5,040 grains, while five seers are not five times 5,040 grains, but five times 4,900 grains, to make them commensurate with the Bombay maund.

At the anniversary meeting of the Sanitary Institution of Great Britain, Mr. Edwin Chadwick, chairman, claimed credit to that and similar institutions for a large proportion of the reduction of the death-rate of the metropolis, which had fallen to 14 in 1,000. The rate in Paris is 27, in Vienna, 30, and in St. Petersburg 40 per 1,000. Dr. B. W. Richardson delivered an address on "The Storage of Life as a Sanitary Study," by which he meant, substantially, the art of living long.

While the summer of 1888 was unusually cool and moist in the United States and the most of Europe, the people of Norway endured a heat which is said to have surpassed the highest before observed during this century.

"The sight-seer's headache" is the name given to an affliction from which frequenters of picture-galleries and museums suffer. It is a result in part of the effort of the mind consequent upon long-continued observation, and partly of the muscular strain involved in that work; but is chiefly produced—in sufferers who are burdened with catalogues—by the frequent movement of the eye from the book to the object, and the incessantly repeated readjustments of the focus of vision which are made necessary in looking now at one, now at the other.

The advance that has been realized in the power of sanitation is exemplified, according to Mr. Edwin Chadwick's review, in the military services of the United Kingdom. A quarter of a century ago, the death-rate in the Guards was 20 per 1,000; it is now 6½ per 1,000. The death-rate in the home army has been reduced in the same time from 17 to 8 per 1,000. In the Indian army the old death-rate was 60 per 1,000; from 1879 to 1884 it was reduced to 20 per 1,000; and it is now about 14 per 1,000. In the six years from 1879 to 1884, the aggregate saving was 16,910 lives, the money value of which is estimated at £1,691,000.

General Pitt Rivers has remarked that the difference in results caused by different methods of estimating the same skeleton by the most famous English physical anthropologist is not less than four inches. Dr. Beddoe proposes as a rule to add to thrice the length of the femur in inches 13 inches, and one half of any excess over 19 inches in the case of a man, reading 12½ and 17½ in the case of a woman.

A favorable report was given of the growth and prospects of the Bridgeport (Conn.) Scientific Society at the opening of the lecture course of 1888–'89. The society puts actual work and investigation by its members foremost among its objects, while the lectures are a secondary consideration. It is about to be endowed with a permanent home through the liberality of Mr. P. T. Barnum. Mr. Barnum made the opening address of the season's lectures, and having spoken'of the benefits which science has conferred upon mankind, urged prompt and full recognition of the city's benefactors.

The origin of the experimental farm at Rothamstead is attributed in the "Pall Mall Gazette" to a remark made to Mr. Lawes by Lord Dacre to the effect that bones used as manure produced excellent results on one farm, while on another they were comparatively useless. This led to the institution of experiments with different fertilizers. Sir John Lawes is arranging to put his laboratory and the land on which the experiments have been made, with £100,000 as an endowment, into the hands of trustees to be appointed by the Royal and two other societies. Thus there will be no end or interruption to the work after the death of Dr. Gilbert and himself.

Specimens of what may prove to be a new species of chimpanzee have been attracting attention at the London Zoölogical Society's gardens. They are characterized by being bald-headed—are possibly identical with M. Du Chaillu's *Troglodytes calvus*—and the name *Anthropopithecus calvus* has been provisionally given them. Living specimens of all the three known anthropoid apes may now be seen at the society's houses.

An expedition is projected in Norway to be dispatched in the summer of 1890 in an attempt to reach the north pole by way of Franz-Josef Land. The leadership of it is to be offered to Dr. Nansen.

The crater lakes of the volcanic Eifel have been found by Dr. Otto Zacharias to be inhabited by numerous species of *Copepoda*, *Daphnidæ*, *Radiolaria*, *Rotiers*, water-mites, and insect larvæ. The largest of them, the Laacher See, which is about seven miles in circumference, contains a special fauna.

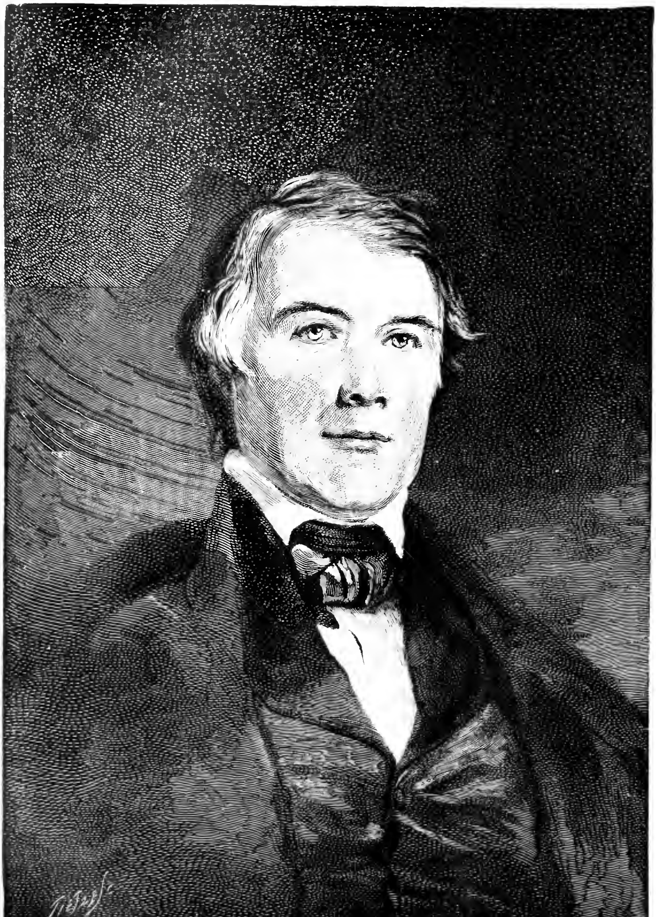
Parts of the monument that was erected in London by Sir Christopher Wren, to commemorate the Great Fire, are showing signs of decay. The limestone of which it is built is acted upon by the acids of the London atmosphere—an agency which had no perceptible existence in Wren's time, but is becoming more and more obvious in large cities and manufacturing towns.

OBITUARY NOTES.

Prof. Richard Vine Tuson, of the Royal Veterinary College, London, died October 31, 1888. He had been Professor of Chemistry in the institution named for more than twenty years; was a "thorough chemist and able teacher and experimenter"; and was the author of various scientific papers, and editor of the new edition of Cooley's "Dictionary of Receipts."

Dr. Peter Griess, a British chemist, died at Bournemouth, September 6th. He was best known as the discoverer of those remarkable substances, the diazo-compounds.

Dr. Nathan Allen, of Lowell, Mass., a physician and medical writer well known to readers of the "Monthly," died on the 1st day of January, from the effects of a fall down-stairs resulting in concussion of the brain. He was distinguished as a specialist in the subjects of physical culture and degeneracy, insanity and state medicine, heredity, hygiene, education, intemperance, and the family institution, and particularly of the falling off in the birth-rate among native New England families; on these subjects he published several important works and numerous shorter articles.



JAMES P. ESPY.

THE

POPULAR SCIENCE MONTHLY.

APRIL, 1889.

THE PSYCHOLOGY OF SPIRITUALISM.

By JOSEPH JASTROW.

IN 1848, from the town of Hydeville, New York, came the somewhat startling discovery that certain knockings, the source of which had mystified the household of one of its residents, seemed to be intelligently guided and ready to appear at call. Communication was established by agreeing that one rap should mean "no," and three raps "yes"; to which was afterward added the device of calling off the alphabet and noting at which letters the raps occurred; in this way the rapper revealed himself as the spirit of a murdered peddler. Within five years the news of this simple and childish invention had called into existence thousands of spirit-circles, had developed wonderful "mediums," through whose special gifts the manifestations were ascribed, had amassed a vast store of strange testimony, and the movement had become an epidemic; and this, too, in spite of the fact that, in 1851, the peculiar double raps occurring in the presence of these Fox sisters *

* Since this article was written, Margaret Fox (now Mrs. Kane) and Katie Fox (now Mrs. Jencken) have publicly confessed that the raps to which they as children gave rise were produced by dislocations of the toes. They have publicly shown the method of their production, and seem earnestly desirous of retarding the growth of the movement to which they so unintentionally gave rise. They plead for our mercy, on the ground that the movement was started when they were too young to appreciate what was being done, and that, when they realized the fraud and the encouragement they were receiving, it was too late or too difficult to retract. It is a pity that this confession comes so late, and the more so, that it has been made under such sensational surroundings. Had the confession been placed in the hands of a respectable scientific body, such as the Seybert commission, a more lasting service to mankind would have resulted. But none the less is it proper to derive from this confession a valuable lesson for intending investigators, and a characteristic proof of the moral taint in which the germs of this growth were laid and have developed.

were satisfactorily explained as due to the rapid partial dislocation and resetting of the knee-joint, and perhaps other joints, the raps failing to occur when the Fox sisters were placed in a position in which the leverage necessary for this action was denied them and being perfectly repeated, at will, by a lady gifted with the same peculiarity. To-day spiritualists count their adherents by millions. In 1867 there were estimated to be three millions in America. They publish about one hundred journals, hailing from all parts of the world (twenty-six of them appear in America), and the manifestations have increased in number and variety. Spirit-forms are seen and hold converse; they write on slates in mysterious ways, they move tables, play musical instruments, send flowers and messages, tie knots in an endless cord, and so on; all, however, only in the presence of "mediums."

It would seem self-evident that so momentous a conclusion should not be accepted without the most rigid scrutiny; that only after every attempt to explain the phenomena by laws already understood had failed, would recourse be had to a supernatural origin, and only when the truth of such a theory had been repeatedly verified by a variety of evidence would it be definitely accepted. The history of psychic epidemics shows too clearly that any such logical procedure is made impossible by the white heat of the emotional interest with which such movements always spread. There is always a large class of people yearning for a possession that shall be mysterious and unshared by the common herd, anxious to embrace any such strange and novel doctrines as spiritualism advanced, simply because of their strangeness and novelty. Such persons find no satisfaction in investigating, but only in believing. With such the movement began; but, as it spread, it found its way into higher circles, securing the adherence of many men and women of decided culture and intellectual acumen, and even enrolling in its cause a few eminent representatives of the world of learning. The spiritualists grew bold and defied investigation; investigations were frequently made, and resulted, according to the ability, impartiality, and technical fitness of the investigators, about as frequently in exposure as in conversion. The conversions were always trumpeted far and wide, while the mediums convicted of fraudulent procedure quietly and successfully continued their career. A prominent spiritualist openly announces that Slade (perhaps the most famous living medium) "now often cheats with an almost infantile audacity and *naïveté*, while at the same or the next *séance* with the same investigators," genuine spiritualistic phenomena occur. If this is the moral atmosphere of spiritualism, one can readily understand the opinion of another disciple, that the true spirit in which to approach its study is "an entire willingness to be deceived."

With the revival of interest fostered by the Society for Psychic Research, the investigation of spiritualistic manifestations has been undertaken with more of a scientific appreciation of the problems therein involved; and within the last few years have appeared the results of several inquiries that deserve to register a turning-point in the career of this mischievous superstition and to hasten the day of its abandonment by all sensible men.

Mr. Henry Seybert, an enthusiastic spiritualist, bequeathed to the University of Pennsylvania a sum of money, on the condition that this university should appoint a commission to investigate modern spiritualism. This commission has published a preliminary report.* They began with an entire willingness to accept any conclusion warranted by facts; and their chairman, Dr. H. H. Furness, confessed "to a leaning in favor of the substantial truth of spiritualism." They have examined many of the most famous mediums. and the manifestations that have contributed most to their fame. Their verdict, individually and collectively, is the same regarding every medium with whom they saw anything noteworthy: *gross, intentional fraud throughout.* The mediums were treated with the utmost fairness and courtesy; their conditions were agreed to and upheld; every one, in each kind of manifestation, was either caught in the act of trickery, or the trick was repeated and explained by one of the commission. This testimony goes far to justify the substitution of "trick" for "manifestation," of "senseless cant" for "spiritualistic explanation," of "adroit conjurer" for "medium." The accumulative force of this conclusion can only be appreciated by a reading of the report itself. A few examples of the kind of trickery exposed must here suffice.†

Dr. Slade, whose mediumship has convinced many of the most eminent believers in spiritualism, including the famous Zöllner *coterie*,‡ produces communications on a slate held beneath a table,

* "Preliminary Report of the Commission appointed by the University of Pennsylvania, to investigate Modern Spiritualism," Philadelphia, 1887, Lippincott, pp. 159. The members of the commission are: Dr. William Pepper, Dr. Joseph Leidy, Dr. G. S. Koenig, Prof. R. E. Thompson, Prof. G. S. Fullerton, Dr. H. H. Furness, Mr. Coleman Sellers, Dr. J. W. White, Dr. C. B. Knerr, and Dr. S. Weir Mitchell.

† It is often claimed that, while mercenary purposes can explain the existence of professional mediums, the manifestations of private mediums remain as the bulwark of faith. It is doubtless true that the method of investigating private manifestations must be a different one, and this yet remains to be done in a careful and scientific manner. The difficulty has always been in the unwillingness of private mediums to appear before examining bodies. It must also be remembered that amateur mediums, even when there was no ground for suspicion, have been exposed as frauds (*vide* "Seybert Report," p. 122); and the passion for deceiving, so characteristic of hysterical natures, is as strong as the greed for gain. The subject merits a separate discussion.

‡ This is always cited as one of the triumphs of spiritualism. As usually told, it reads that a few eminent scientists, especially fitted to investigate such matters, were convinced

in answer to questions asked in writing or verbally, sometimes openly and sometimes in folded slips of paper. It was soon discovered that the character of this writing was of two kinds. The long messages were neatly written, with the *i's* dotted and the *t's* crossed, and often produced unasked, or not in direct answer to a question; while the short ones, in answer to questions asked only shortly beforehand, were scrawly, hardly legible, and evidently written without the aid of the eye. The many methods of producing the short writings were repeated by a professional prestidigitateur much more skillfully than by Slade. The commission distinctly saw every step in Slade's method, on one occasion or another, but were utterly baffled by the conjurer (Mr. Harry Kellar), who subsequently revealed his methods to Dr. Furness. The long messages are written beforehand, on slates to be substituted for the ones given him at a favorable opportunity. At the last *séance* with Dr. Slade, two prepared slates were resting against a table behind him, and Dr. Furness kept a sharp watch upon these slates. "Unfortunately, it was too sharp; for one second the medium saw me looking at them. It was enough. That detected look prevented the revelation of those elaborate spirit messages. But when the *séance* was over, and he was signing the receipt for his money, I passed round behind his chair and pushed these slates with my foot, so as to make them fall over, whereupon the writing on one of them was distinctly revealed." The medium at once pushed back his chair, snatched the slates, hurriedly washed them, and could with difficulty regain sufficient composure to sign the receipt for the exorbitant payment of his services. This is not the first time that Slade has been exposed, and it is hoped that this verdict of the Seybert commission, "fraudulent throughout," will be sufficient to make further exposure unnecessary.*

Another medium, Mrs. Patterson, gives a closely similar performance. Dr. Knerr had a sitting with her, and adjusted a mirror

of the supernatural origin of Slade's performances, and one of their number (Zöllner) found the theory of their explanation in harmony with the mathematical notions of the fourth dimension of space. Prof. G. S. Fullerton, the secretary of the Seybert commission, has interviewed Zöllner's associates, and finds that, "of the four eminent men whose names have made famous the investigation, there is reason to believe one, *Zöllner*, was of unsound mind at the time, and anxious for an experimental demonstration of an already accepted hypothesis (the fourth dimension of space); another, *Fechner*, was partly blind, and believed because of Zöllner's observations; a third, *Scheibner*, was also afflicted with defective vision, and not entirely satisfied in his own mind as to the phenomena; and a fourth, *Weber*, was advanced in age, and did not even recognize the disabilities of his associates." None knew anything about conjuring, and, deservedly honored as these men are in their own specialties, they were certainly not fitted to compete with a professional like Slade.

* Another member of the commission (Mr. Coleman Sellers) says, with regard to Slade: "The methods of this medium's operations appear to me to be perfectly transparent, and I wish to say emphatically that I am astonished beyond expression at the confidence of this

about his person so as to reflect whatever was going on beneath the table. "In the mirror I beheld a hand . . . stealthily insert its fingers between the leaves of the slate, take out the little slip (containing the question), unfold and again fold it, grasp the little pencil . . . and with rapid but noiseless motion . . . write across the slate from left to right a few lines; then the leaves of the slate were closed, the little pencil laid on the top," and the spirits invoked to please send a message.

Is it necessary to continue the catalogue of vulgar deceit: to tell how Dr. Furness sends out sealed letters the contents of which the spirits are to read and answer without opening, and finds the seals tampered with and mucilage and skill used to conceal the crime; how he asks the same question of various mediums and receives hopelessly contradictory answers; how he detects the form of the medium in her assumed materializations and finds the spirit ready to answer to any and every name in fiction or reality, from "Olivia" of "The Talking Oak" to Shakespeare; how a medium who materializes a right hand while apparently holding his neighbor's hand with both his own, is shown to imitate this double grip with one hand and do the hocus-pocus with the other—in short, how universal, how coarse, how degrading this fraud is; how readily it leaves its hiding-place to snatch at a cunningly offered bait, until it becomes ridiculous? *

Let us rather turn to another independent investigation published by the English Society for Psychical Research (October, 1886, to May, 1887). The great English medium, whose performances as described are really miraculous, is Englinton, and his specialty is slate-writing. The late Prof. H. Carvill Lewis (of Philadelphia) had sittings with Englinton, and reported as follows: He sat intently watching Englinton for an hour, and nothing happened; fearing a blank *séance*, he purposely diverted his attention. The moment he looked away, the manifestations began, and he could see "the medium look down intently toward his knees and

man in his ability to deceive, and at the recklessness of the risks which he assumes in the most barefaced manner. The only reason of our having any so-called 'manifestations,' under the circumstances, was because of the fact that the committee had agreed in advance to be entirely passive, and to acquiesce in every condition imposed."

Mrs. Sidgwick, an able English observer, detected the fraudulent character of Slade's performances from the beginning. She points out five important grounds of suspicion: "His conjurer-like way of trying to distract one's attention, his always sitting so as to have the right hand to manipulate the slate, the vague and general character of the communications, his compelling one to sit with one's hands in a position that makes it difficult to look under the table, and his only allowing two sitters at a time."

* The barefacedness of the medium's business reaches its climax in the fact (communicated to me by Dr. Furness) that a noted medium had visited a professional juggler, and, "*making no secret to him of his trickery as medium for independent slate-writing, had purchased from the juggler several other tricks with which to carry on his spiritualistic trade.*"

in the direction of the slate. I now quickly turned back my head, when the slate was brought up against the table with a sharp rap." He repeated the manœuvre, with the same result, and while the writing was going on he distinctly saw "the movement of the central tendon in his wrist corresponding to that made by his middle finger in the act of writing. Each movement of the tendon was simultaneously accompanied by the sound of a scratch on the slate." Again, for the answer to another question, Englinton requires the use of a dictionary, and leaves the room for a minute; the answer is then written just as it is given in Webster's dictionary; but, unfortunately, *albumina* was read for *alumina*. When the slate, which closes with a spring, is to be closed, Englinton suddenly sneezes; when the writing is small and faint, he struggles until he gets within a few inches of it; a postage-stamp secretly glued across the two leaves of the double slate prevents all manifestations; a double fee immediately causes further manifestations, while a minute before such were declared impossible, owing to the exhaustion of power; and the writing on the slates is identified by an expert as that of Englinton.*

Mrs. Henry Sidgwick records her experience with many mediums, and supports the same verdict. She was often unable to detect the exact *modus operandi* of the medium, but has never seen anything which was not well within the range and strongly suggestive of conjuring, and mostly of no high order of conjuring.

But all this accounts for only part of the problem. To convict every medium of fraud is not a complete explanation of the appearance which this belief now presents. It remains to account for the great success of the movement; for the fact that so many have been deceived and so few have really understood; to show why we are to believe the Seybert commission, and not credit the countless miracle-mongers. This is psychologically the most interesting portion of the problem, and has recently been very successfully treated by Mrs. Sidgwick, Mr. Hodgson, and Mr. Davey, of the English Society for Psychic Research.

There is a very broad-spread notion that anybody can go to a spiritualistic *séance* and give a reliable opinion as to whether what he or she has seen is explicable as conjuring or not. Especially in this country, where the right to one's opinion is regarded as a corollary to the right of liberty, does this notion prevail. The

* If further proof be required of the degrading contrivances to which this medium will resort, we have it in his conviction of connivance with Mme. Blavatsky in the production of a spurious theosophic marvel, as well as in the following evidence supplied by Mr. Padshah and indorsed by Mr. Hodgson (the exposer of Mme. Blavatsky): Mr. Padshah and a friend had asked for Gujerati writing at a *séance*, but did not get it; the former then anonymously sent a poem in Gujerati to Englinton, and his friend (who was not initiated in the trick) brought the same copied in every detail on a slate as the direct revelation of the spirits in a sitting with the medium!

fact probably is, that most such claimants are about as competent to form a trustworthy opinion on such a subject as they are to pronounce upon the genuineness of a Syriac manuscript. The matter is as much a technical acquisition as is the diagnosticating of a disease. It is not at all to the discredit of the observing powers or the intellectual acumen of any one, to be deceived by the performances of a conjurer, and the same holds true of the professional part of mediumistic phenomena.* Until this homely but salutary truth is impressed with all its importance upon all intending investigators, there is little hope of checking the growth of this vast superstition.† You believe that there will be an eclipse of the moon when the astronomer predicts one, not because you can calculate the time yourself, or even understand how the astronomer does it, but because that is a technical acquisition which

* "I do not think that this unpreparedness and inobservancy of mind, in the presence of a conjurer, is a thing of which any one who is not familiar with the tricks already need be ashamed."—*Mr. Hodgson.*

Even a conjurer can be nonplussed by a medium's performance if he have no experience in the particular kind of sleight of hand required for the trick. This is the experience of Mr. Harry Kellar. He at first declared himself unable to explain slate-writing as a trick, but now can repeat the process in a variety of ways, and with far greater skill than mediums. Of course the spiritualists keep on citing his former testimony, and ignore his challenge to repeat by trickery any alleged spiritualistic phenomena witnessed by him three times.

† The above view ought, perhaps, to be modified somewhat. There is a class of spiritualistic manifestations, to be deceived by which is a mark of weak insight or strong prejudice. To this class belong the materialization of departed friends. On these Dr. Furness writes thus: "Again and again men have led round the circles the materialized spirits of their wives and introduced them to each visitor in turn; fathers have taken round their daughters, and I have seen widows sob in the arms of their dead husbands. Testimony such as this staggers me. Have I been smitten with color-blindness? Before me, as far as I can detect, stands the very medium herself, in shape, size, form, and feature true to a line, and yet one after another, honest men and women at my side, within ten minutes of each other, assert that she is the absolute counterpart of their nearest and dearest friend; nay, that she *is* that friend. It is as incomprehensible to me as the assertion that the heavens are green, and the leaves of the trees deep blue. Can it be that the faculty of observation and comparison is rare, and that our features are really vague and misty to our best friends? Is it that the medium exercises some mesmeric influence on her visitors, who are thus made to accept the faces which she wills them to see? Or is it, after all, only the dim light and a fresh illustration of *la nuit tous les chats sont gris?*" Add to this the confession of an exposed medium, Mr. D. D. Home: "The first *séance* I held, after it became known to the Rochester people that I was a medium, a gentleman from Chicago recognized his daughter Lizzie in me after I had covered my small mustache with a piece of flesh-colored cloth, and reduced the size of my face with a shawl I had purposely hung up in the back of the cabinet." Cases where different members of a circle instantly recognize in the spirit form entirely different persons are not uncommon. Here so much of the trick depends upon the sitter that he must be a firm believer, or very simple, to be deceived. It is this kind of manifestations with which the better class of spiritualists have least to do; and it is seldom that a conversion of a real investigator begins with such materializations. This preying upon the feelings of simple-minded folk is one of the greatest scandals of the movement.

he has learned and you have not; and so with a thousand other and more humble facts of daily life. Spiritualism (to a large extent) comes under the same category; and the Seybert commission, and these other observers who have acquainted themselves with the possibilities of conjuring and the natural history of deception, who by their training and natural gifts have fitted themselves as competent judges of such alleged ultra-physical facts—these persons have the same right to our confidence and respect as a body of chemists or physicians on a question within their province. It is not fair to set up what you think you have seen as overthrowing their authority; even if you are an unprejudiced and accurate observer who has weighed the probability of your observations being vitiated by one or other of the many sources of error in such observation, it is only a small fact, though of course even that should be registered.

Whatever of seeming dogmatism there is in this view is removed by the experimental demonstration furnished by Messrs. Hodgson and Davey, that the kind and amount of mal-observation and faulty description which an average observer will introduce into the account of a performance such as the medium gives, is amply sufficient to account for the divergence between his report of the performance and what really occurred. The success of a large class of tricks depends upon diverting the observer's attention from the points of real importance, and in leading him to draw inferences perfectly valid under ordinary circumstances but entirely wrong in the particular case. It must be constantly remembered that the judging powers are at a great disadvantage in observing such performances, and that it is a kind of judgment in which they have no practice. In the intercourse of daily life a certain amount of good faith and confidence in the straightforwardness of the doings of others prevents us from exercising that close scrutiny and suspicion here necessary. We know that most of our neighbors have not the sharpness to deceive us, and do not live on the principle of the detective, who regards every one as dishonest until he has proved himself honest.

Mr. Davey (who, by the way, was at one time deceived almost into conversion by spiritualistic phenomena) is an expert amateur conjurer, and repeats the slate-writing performances of such as Englinton with at least equal skill. He arranged with Mr. Hodgson to give sittings to several ladies and gentlemen, on the condition that the latter send him detailed written accounts of what they had seen. He did not pose as a medium or accept a fee, but simply said that he had something to show which his sitters were to explain as best they could, and with due consideration of trickery as a possible mode of explanation. The "medium" has here a decided advantage over Mr. Davey, because he induces a mental attitude in his sitters that entertains (however remotely) the possibility of witnessing something supernatural, and this is sufficient to create an adjustment of the powers of observation less fitted to detect trickery than if the performer did not announce himself as the go-between of the supernatural. This is well illustrated in the reports of Mr. Davey's sitters, for a few friends who were told beforehand that they were to witness a sleight-of-hand performance, or were strongly led to believe it such, made much less of a marvel of the performance than those who had not been thus enlightened. It remains to add that not one of the sitters (and they were persons of decidedly more than average intelligence and ability) detected his *modus operandi*, and a large number concluded that trickery was utterly insufficient to account for the manifestations.

Mr. Davey's performances, *as described* by many of his sitters, like the descriptions of the performances of many a medium, are marvelous enough to demand the hypothesis of occult agency: "Writing upon slates locked and carefully guarded by witnesses—writing upon slates held by the witnesses firmly against the under surface of the table—writing upon slates held by the witnesses above the table—answers to questions written secretly in locked slates—correct quotations appearing on guarded slates from books chosen by the witnesses at random, and sometimes mentally, the books not touched by the 'medium'; . . . messages in languages unknown to the 'medium,' including a message in German, for which only a mental request had been made, and a letter in Japanese in a double slate locked and sealed by the witness, etc. And yet, though 'autographic' fragments of pencil were 'heard' weaving mysterious messages between and under and over slates, and fragments of chalk were seen moving about under a tumbler placed above the table in full view, none of the sitters witnessed that best phenomenon, *Mr. Davey writing.*"

It must not be supposed that the errors of mal-description and lapse of memory thus committed are at all serious in themselves; on the contrary, they are mostly such as would be entirely pardonable in ordinary matters. Mr. Hodgson places them in four classes. In the first, the observer *interpolates* a fact which really did not happen, but which he was led to believe had occurred. He records that he examined the slate, when he really did not. Or, for similar causes, he *substitutes* one statement for another closely like it; he says he examined the slate minutely, when he really only did so hastily. Thirdly, he may *transpose* the order in which the events happened, making the examination of the slate occur at a later period than when it really took place. Lastly, he may *omit* certain details which he was carefully led to consider trivial, but which really were most important. Such slight lapses as these are sufficient to make a marvel of a clever piece of conjuring; add to this the increased temptations for mal-observation afforded by the dim light and mysterious surroundings of the medium, as well as by the sympathetic attitude of the sitters, and the wide divergence between the miraculous narratives of spiritualists and the homely deceptions which they are intended to describe is no longer a mystery.

The conclusion thus experimentally arrived at by Messrs. Hodgson and Davey is corroborated by other investigators. After witnessing a *séance* that was simply a series of the simplest and most glaringly evident tricks, Mrs. Sidgwick was expected to have had all her doubts entirely removed, and was assured that what she had seen was better than the materializations at Paris. "Experiences like this make one feel how misleading the accounts of some completely honest witnesses may be; for the materializations in Paris were those which the Comte de Bullet had with Firman, where near relatives of the count were believed constantly to appear, and which are among the most wonderful recorded in spiritualistic literature. And, after all, it appears that these marvelous *séances* were no better than this miserable personation by Haxby."

The Seybert commission finds that "with every possible desire on the part of spiritualists to tell the truth, the whole truth, and nothing but the truth, concerning marvelous phenomena, it is extremely difficult to do so. Be it distinctly understood that we do not for an instant impute willful perversion of the truth. All that we mean is that, for two reasons, it is likely that the marvels of spiritualism will be, by believers in them, incorrectly and insufficiently reported. The first reason is to be found in the mental condition of the observer; if he be excited or deeply moved, his account can not but be affected, and essential details will surely be distorted. For a second reason, note how hard it is to give a truthful account of any common, every-day occurrence. The difficulty is increased a hundred-fold when what we would tell partakes of the wonderful. Who can truthfully describe a juggler's trick? Who would hesitate to affirm that a watch, which never left the eye-sight for an instant, was broken by the juggler on an anvil; or that a handkerchief was burned before our eyes? We all know the juggler does not break the watch, and does not burn the handkerchief. We watched most closely the juggler's right hand, while the trick was done with his left. The one minute circumstance has been omitted that would have converted the trick into no-trick. It is likely to be the same in the accounts of the most wonderful phenomena of spiritualism."

If we desire a concrete instance of this omission of an important detail, Dr. Furness will supply one. Certain highly intelligent observers describe to him the doings of a Boston medium: "There are two tables in the room of *séance*, at one of which sits the medium, at the other the visitor. The visitor at his table writes his question in pencil at the top of a long slip of paper, and, after folding over several times the portion of the slip on which his question is written, gums it down with mucilage and hands it to the medium, who thereupon places on the folded and gummed portion his left hand, and in a few minutes with his right hand writes down answers to the concealed questions; these answers are marvels of pertinency, and prove beyond a cavil the clairvoyant or spiritual powers of the medium." Dr. Furness went to the medium, prepared his slip of paper about as described, and thus continues: "As soon as he took his seat, and laid the strip on his table before him, I rose and approached the table so as to keep my paper still in sight; *the row of books entirely intercepted my view of it.* The medium instantly motioned to me to return to my seat, and, I think, told me to do so. I obeyed, and as I did so could not repress a profound sigh. Why had no one ever told me of that row of books?"

Before passing sentence one must hear what the defendant has to say. The usual defense consists in claiming that the conviction of fraud in some mediums does not prove the absence of genuine phenomena in others. Some even claim, as we saw, that fraud and spirit manifestations can go hand in hand. Furthermore, they hold that the conditions for success demanded by the mediums, though they make the phenomena resemble a juggler's performance, are perfectly explicable on spiritualistic grounds. Writing is best produced in the dark because dark is "negative," light "positive," and negative conditions are most favorable to communication; if the spirit that appears resembles the medium, that is an effect of the materializing process; if writing does not occur when the slate is looked at, it is because the magnetism of the eye is unfavorable; and has not Dr. Slade received an express command from the spirits forbidding him, on penalty of cutting off all communication, to attempt to write on sealed slates?

In the first place, while it is not thus proved that every action of every medium is fraudulent, it makes it more and more probable, especially as the very conditions necessary for a serious investigation are denied on fanciful grounds. The fact that scientific examination everywhere reveals deception makes it extremely probable that, when exposure has not taken place, it is because there was no scientific examination. At any rate, the burden of proof is with the claimants for supernatural manifestations, and their case has now been so much weakened that it can no longer enter as a serious possibility into the minds of such as guide their beliefs by reason. Again, their "spiritualistic" explanations are simply violent assumptions, varying with the caprice and ingenuity of every medium, and evidently manufactured for the purpose. Even if such explanations were consistent, they would be possible only in that extreme sense in which any bizarre notion or fantastic hypothesis is possible. Practically, they are impossible, because contradictory to the fundamental tenets of science and experience; because they are opposed to that marvelous network of mutually corroborating laws and observations upon which the logic of civilization is founded. Those whose feelings are not appealed to by the doctrines of spiritualism will never be attracted to it by its logic.

A system that aims to instruct men with regard to beliefs appealing most earnestly and deeply to the human heart, appears in the light of scientific investigation as an empty, tottering framework, held together by the grossest frauds, covered over with the most vulgar sham, and embellished with the meanest kind of deception. Let each one leave as small or as large a margin for the possibility of a genuine spiritualism as to him seems fit, but let him realize in all its immensity the gross scandal to which this system has given and is giving rise. Let him understand that under the shelter of spiritualism men and women in all our large cities are daily and hourly preying upon the credulity of simple-minded folk, and obtaining money by means for which the law provides the jail. Let him know that there is now abundant evidence to make the term "medium" synonymous with "impostor." When these facts are clearly and universally recognized, we may hope to ascertain whether there is a true but small foundation-stone hidden beneath this rubbish-heap, or whether, like its equally pretentious predecessors, it leaves the mystery as unsolved as it found it.

According to Prof. Judd, an important change has taken place in scientific opinion concerning the climatical relations of fauna and flora, and the distribution of biological regions. It has been tacitly assumed that all marine organisms coming from regions bordering the equator must have lived under tropical conditions; but deep-sea research has shown that all conditions of temperature and of light prevail at their several depths in tropical as well as other seas; and that many forms which, because they came from equatorial regions, we have hitherto regarded as tropical, we now know to live in icy-cold water as well as in almost utter darkness. The large size and abundant development of cephalopods, crustaceans, and fish, we now know to be no evidence of the presence of warmth or life, and Sir Joseph Hooker has shown the fallacy of similar reasoning when applied to plant-life.

THE CHEMICAL ELEMENTS:

HISTORY OF THE CONCEPTION WHICH THIS TERM INVOLVES.

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THE intellectual force of Aristotle ruled in chemistry even longer than in other departments of physical science. In mechanics and astronomy the dogmas of Aristotle were effectually laid by Galileo early in the seventeenth century; but his doctrine of the four elements*—in one form or other—was accepted in chemistry to the close of the eighteenth century. The wonderful history of the philosophy of the great Stagirite—a philosophy which ruled the intellectual world in physics as well as in metaphysics for more than twenty centuries—is constantly referred to as an illustration of the vices of speculative thought when not based on experimental evidences; and, undoubtedly, the aberrations of many of his later disciples justify this opinion. Among these Kepler is especially conspicuous, for he, by applying the doctrines in a most grotesque and absurd manner, did not a little to bring Aristotle's philosophy of mechanics into contempt. Nevertheless, Aristotle himself was for his time an acute observer, as his writings abundantly indicate; and his philosophical views are brought forward rather to justify his conclusions than as the basis of his inferences. So it is with the doctrine of the four elements. Earth, water, air, and fire were obviously to him the essences, or, to use a later and more descriptive word, the "substantia" of four conditions of matter. Three of these we recognize as clearly as he did; and the fourth, fire, which he regarded as a more sublimated condition than air, and thought he actually saw in the upward motion of flames, has its modern representative in Mr. Crookes's fourth condition of matter.

Since Aristotle regarded motion as an attribute of inanimate as well as of living bodies—a stone falling for the same reason that a fish swims—and as he noticed that while water and stones tend to fall, flame and air tend to rise, he regarded the last as having a natural motion upward, and the first as having a natural motion downward; and thus to him specific levity seemed as much a direct inference of observation as specific gravity. By this inherent motion the four elements appeared to strive to separate, and each to tend to its own place—fire taking the highest place, air the

* The doctrine of the four elements, although usually associated with Aristotle, is really as old as Greek philosophy, and can certainly be traced back to Empedocles, who lived in the second third of the fifth century before Christ—that is, a century before the time of Aristotle.

next, water the next, and earth the lowest. The reasons urged in support of these conclusions appear to us absurd enough.

By Aristotle, as by other Greek philosophers, the contrasts emphasized by language were regarded as fundamental distinctions in nature, or first principles, which they made the basis of discussion, and from which they sought to deduce general truths. Aristotle enumerates ten such principles as enunciated by the Pythagoreans—limited and unlimited, odd and even, one and many, right and left, male and female, rest and motion, straight and curved, light and darkness, good and evil, square and oblong—and from oppositions of this kind he deduced his doctrine of the four elements.

"We seek," Aristotle writes, "the principles of sensible things, that is, of tangible bodies. We must take, therefore, not all the contrarieties of quality, but those only which have reference to the touch. Thus, black and white, sweet and bitter, do not differ as tangible qualities, and must therefore be rejected from our consideration. Now, the contrarieties of quality which refer to the touch are these: hot, cold; dry, wet; heavy, light; hard, soft; unctuous, meager; rough, smooth; dense, rare." Then, after rejecting all but the first four of these, either because they are not active and passive qualities, or because they are combinations of the first four, and concluding for these reasons that the four retained must be elements, he proceeds: "Now, in four things there are six combinations of two; but the combinations of two opposites, as hot and cold, must be rejected. We have, therefore, four elementary combinations which agree with the four apparently elementary bodies: fire is hot and dry; air is hot and wet (for steam is air); water is cold and wet; earth is cold and dry."

In a similar way, by considering light as opposite to heavy, Aristotle justifies his conclusion that levity is a quality of a body, and that bodies are absolutely heavy or absolutely light. "Former writers," he says, "have considered heavy and light relatively only—taking cases where both things have weight, but one is lighter than the other, and they imagined that in this way they defined what was absolutely heavy and light." Fire and air, according to Aristotle, were absolutely light, with fire the lighter of the two; while water and earth were absolutely heavy, with earth the heavier of the two. In another place he writes, "Heavy and light are, as it were, the embers or sparks of motion"; and hence he concluded that the tendency of light bodies to rise, like the tendency of heavy bodies to fall, was an inherent quality.

Subsequently Aristotle recognized a fifth element in nature. In his book "On the Heavens" he wrote: "The simple elements must have simple motions; and thus fire and air have their natural motions upward, and water and earth have their natural motions downward. But, besides these motions, there is motion in a circle, which is unnatural to these elements, but which is a more perfect motion than the other, because a circle is a perfect line, and a straight line is not; and there must be something to which this motion is natural. From this it is evident that there is some essence of body different from those of the four elements, more divine than those and superior to them. If things which move in a circle move contrary to nature, it is marvelous or rather absurd that this, the unnatural motion, should alone be continuous and eternal; for unnatural motions decay speedily. And so from all this we must collect that, besides the four elements which we have here and about us, there is another removed far off, and the more excellent in proportion as it is more distant from us." This element was called the *quinta essentia* by Latin writers, and the word *quintessence* in our own language frequently brings to mind this singular conception, which, although so absurd to us, held for ages a wonderful control over the human mind.

It is not, however, our purpose to trace the influence of the dynamical conceptions of Aristotle on the development of physical science, interesting and instructive as such a study would be. We are here dealing only with the conception of an element or principle of material bodies, also involved in this reasoning; and it is obvious that this early conception of an element was not that of a definite substance—as we now understand the word substance—that is, something *subsistens per se*—but rather that of the *essentia* or *substantia* which were supposed to underlie the external attributes of bodies, and of which these last were merely accidents. Earth was the underlying principle of all solid bodies, whose multifarious forms were as familiar to Aristotle as to us. So all liquid bodies were forms of water, and all aëriform bodies manifestations of the all-diffusive air; and the ancients, at times even more acute than ourselves, made distinctions between conditions, both of water and air, which we know are not essential.

We know that flame is simply intensely heated gas rising in a denser atmosphere; but it was perfectly natural that the ancients should regard such a startling effect as a manifestation of a fourth condition of matter still lighter and more subtile than air, and the conception of fire as a fundamental principle of nature once formed, the phenomena of combustion appeared to them as direct evidences of the escape of this principle of fire from the burning bodies.

The famous theory of phlogiston, advanced by Becher and Stahl during the seventeenth century, was simply a development of these views without any essential change. Phlogiston was merely a new name for the fourth element of Aristotle. As by Aristotle all combustible bodies were assumed to hold the principle of fire, so, on the new theory, they were regarded as compounds of phlogiston, and, in burning, the phlogiston was supposed to escape into the atmosphere. The ease with which such metals as zinc, iron, lead, and tin burn under certain conditions was well known to the chemists of that period, and hence all metals were regarded as largely composed of phlogiston; and when it was shown that the oxides, then called *calces*, resulting from the burning, weighed more than the metal burned, the facts were cited to prove that phlogiston was specifically light, and therefore, when removed from a body, added to its weight.

It has been said that the increase of weight resulting from burning and other forms of oxidation was not recognized until Lavoisier introduced the balance into chemical investigations at the close of the last century; but, although such phenomena could not be formulated under a general principle until after the discovery of oxygen in 1774 (nearly simultaneously both by Priestley and by Scheele), the fact that the so-called *calces* resulting from the burning of the metals weigh more than the metals was well known to metallurgists from a much earlier period. Thus Lémery, who died in 1715, in his well-known treatise on chemistry, describes the increase of weight attending the calcination both of tin and lead; and Boerhaave, a famous Dutch physician and chemist of the same period, thus describes the calcination of lead: "And if, while the lead is in fusion, it be kept continually stirring with a spatula, it turns into a red powder called minium, or red lead, in which operation this is further observable that the lead augments in weight."

During the eighteenth century the theory of phlogiston became modified by the increasing knowledge of the definiteness of chemical combination. Like the other constituents of a body, it was held that the phlogiston in combustibles must be united in definite proportions. So, moreover, when, leaving the fuel in the process of combustion, phlogiston entered into union with the air, it could only be absorbed by the atmosphere up to a certain limit. Hence, a candle soon goes out if burned in a confined vessel; because, after the air is saturated with phlogiston, no more can escape from the combustible. Priestley called oxygen gas, when first discovered, dephlogisticated air, because he ascribed its wonderful power of sustaining combustion to the absence of phlogiston, which oxygen gas could therefore absorb to a proportionally great extent. On the other hand, hydrogen was called phlogisticated air; and Cavendish, when he first isolated this exceedingly light and combustible gas, thought he had discovered phlogiston itself.

As has been already intimated, Aristotle's doctrine of the chemical elements was, in some form or other, received by students of chemistry down to the time of Lavoisier, and the aims and practice of alchemy, which for many centuries was the only phase of chemistry studied, were wholly in harmony with this conception. If the metals were all manifestations of the same underlying essence, and differed only in the accidents of external qualities, it was reasonable to suppose that these accidents might be changed. The alchemists were often intelligent men, and knew as well as ourselves that "all is not gold that glitters"; but the resemblances to the precious metals which they sometimes obtained by their empirical methods were sufficient to stimulate effort. They also clearly saw that the value of the prize they sought would vanish in their keeping the moment the secret became known; but this only led them, as it does so many manufacturers of the present day, to invest their processes with all possible mystery, to conceal known facts beneath non-essentials, and to adopt a conventional and highly figurative language for communicating with each other, so that, even with our knowledge of chemistry, the writings of the alchemists are for the most part an unintelligible jargon. Still, their hopes were based on what they regarded as sound philosophy; and, although their efforts were frequently exposed to ridicule on the ground of ill success, no convincing objections were ever raised to the philosophy by which they were guided. That the aims of the alchemists must have appeared reasonable to thinking men is shown by the fact that, even at a late period in the history of this apparent delusion, Sir Isaac Newton, whose scientific sobriety can not be questioned, devoted a great deal of time to experiments on the transmutation of the metals.

During the two thousand years through which the doctrine of a few elementary principles of nature prevailed, the precise form which the elements assumed naturally varied with the general point of view of the students at the time, although for the most part philosophical writers adhered to the statement of Aristotle. By many of the alchemists mercury, sulphur, and salt were regarded as fundamental principles, because the crude materials under these names played such an important part in the hermetic art. Here, however, it was not these crude materials which were regarded as the elements of matter, but sublimated forms of these substances, known as the mercury and sulphur of the philosophers; and for a long time the conceit was cherished that, if once the elemental mercury and sulphur could be isolated, all metals, and, of course, gold and silver among the number, could be manufactured by mixing these elements in the right proportions. Later, when chemistry assumed a pharmaceutical character, the elements were often said to be water, spirit, oil, salt, and earth, of which the first three were regarded as active and the last two as passive principles. These elements, again, were not definite substances, but merely classes of products obtained by distillation, the active principles being those that passed over and the passive principles those that remained behind in this process—a process which at the time had become the typical process of chemistry, and the chemists of this period are always represented in paintings with a retort or alembic, as were the alchemists of an earlier period with a furnace and crucible. This last enumeration of elements is not so different from that of the alchemists as would at first sight seem, for mercury was regarded as the most active of the spirits, and sulphur as one of the oils. Moreover, the distinction between fixed and volatile oils, which dates from this period, shows the generic character of the elements then accepted.

In his "Œdipus Chymicus," first published about the middle of the seventeenth century, Becher, the author of the theory of phlogiston, comes back to the elements of Aristotle, and in this he is followed by Stahl, who elaborated the same theory a generation later. To give an idea of the confusion of thought on this subject, even at a comparatively late period, I will quote from the "Cours de Chimie, par M. Lémery, nouvelle édition, Paris, 1756," a work which remained one of the chief authorities on chemistry down to the time of Lavoisier. I translate freely from the French:

"The first element of compound bodies which we must accept is a universal spirit, which, being universally diffused, produces different results according as it is held in different matrices or pores of the earth; but as this principle is somewhat metaphysical and can not be perceived by the senses, we must distinguish in addition certain elements which are perceptible. I shall name those commonly accepted.

"As chemists in analyzing different compounds have found five kinds of substances, they have concluded that there are five principles of material things—water, spirit, oil, salt, and earth. Of these five there are three which are active principles—spirit, oil, and salt; and two passive—water and earth. The first are called active, because, being endowed with rapid motion, they determine the active qualities of the products into which they enter; and the second are called passive, because, being at rest, they only serve to diminish the vivacity of the active principles."

Then follows a more precise definition of the several principles enumerated, to which in part I have already referred. After this, Lémery remarks:

"The term principle of chemistry must not be taken in an exact sense, for the substances to which we have given this name are principles only relating to our knowledge, and so far as we have been unable to go further in the division of bodies. But we can well understand that these principles may be further divisible into an infinity of parts, which should more properly be called principles. We understand, then, by principles simply such substances as have been separated and divided so far as our feeble efforts are capable of doing." Here is a glimmering of scientific principles. And so again in this sentence:

"Some modern philosophers would persuade us that it is uncertain whether the products we draw from compounds, and which we call principles of chemistry, really exist as such in the compounds. They say that fire, rarefying matter in the process of distillation, is capable of giving an entirely different arrangement to the parts from that which existed before, and may thus form the salt, oil, and other products which are the results of the process."

Lémery himself died in 1715, so that the edition of his work from which we quote was published over forty years after his death, showing that in the slow progress of knowledge at that time the life of a scientific treatise was far longer than it is now. The editor of the new edition adds copious notes, in which he comments on some of the absurdities of his author, plainly indicating that progress toward clearer views was constantly being made; but, at the same time, his own remarks are equally amusing, and give abundant evidence of the utter confusion of thought which still prevailed. To appreciate how great a work Lavoisier accomplished, it is only necessary to read a few pages (more would be intolerable), both of this treatise of Lémery and also of the "New Method of Chemistry" of Boerhaave, the two great standard works on the science of the eighteenth century, both in large quarto volumes. These are far less repulsive than the chemical writings of the previous century, which often dwelt at great length on illustrations of chemical processes from the relations of the sexes. They are less mystical, and frequently describe acute observations of phenomena; but they are equally deficient in scientific spirit, full of crudities and empiricisms of the most trivial kind, and this at a period when the mathematical sciences had attained much of the elegance of form of our own day. Lavoisier is known to us chiefly as the discoverer of the true theory of combustion, but he was truly the father of modern chemistry, and his claim to our regard rests more than anything else on the fact that he gave to the subject for the first time a definite and rigid scientific form. It will help you to appreciate the entire change of conception introduced by Lavoisier if I quote from Fourcroy's "Chemical Philosophy," third edition, 1806, the following significant passage. Fourcroy was a contemporary of Lavoisier, although twelve years younger. Lavoisier, as is well known, fell a victim of the Reign of Terror during the French Revolution in 1794. Fourcroy, more fortunate than his greater colleague, passed through this fearful period unharmed, although he was a member of the Constituent Assembly, and after the fall of Robespierre acted as Secretary of Public Instruction. He was made senator by Napoleon, and died full of honors in 1809, living until the decomposition of the alkalies and alkaline earths had become accomplished facts. As before, I translate from the French very freely:

"Since the revolution effected in chemistry between 1774 and 1784" (the period of Lavoisier's active scientific work) "by the new discoveries which have entirely changed the face of the science, many of the former erroneous and arbitrary distinctions have been given up. The term *principle* is no longer used except in a very general sense, and with the understanding that it applies to different sorts of bodies, some of them simple and some of them compound, depending on the nature of the materials from which they come and on the method of analysis used. All chemists agree to-day that if by principles or elements we understand the original and simple bodies which constitute the primitive molecules of substances, such bodies are wholly unknown, either as regards their number or their properties, and that in discussing them we are yielding to theories as useless as those of monads or atoms. They further agree that if we confine the word *elements* to the last products of analysis which can not be subdivided by analytical means, we must exclude from this class of bodies both the so-called principles of the elder chemists and the four elements of Aristotle, as many of these are compound substances, and we must accept a very much larger number of elements than formerly, for we are acquainted with more than thirty substances which can not be decomposed.

"From the results of numerous and exact analyses chemists know, first, that all natural substances may be divided into simple and compound substances; secondly, that the true distinction of primary or simple substances is ability to resist decomposition, so that the word simple is synonymous with the word undecomposable; thirdly, that by compounds we signify substances which are susceptible of analysis, or from which we can extract materials more simple, or of which the complexity of composition diminishes in degree as the analysis is extended; fourthly, that although compounds of the same class may differ greatly among themselves, it is sufficient for comparison and gives us an exact distinction if we divide them into binaries or compounds formed of two elements, ternaries or compounds formed of three elements, quaternaries or compounds formed of four elements, quinaries, sextaries, etc., according as the number of the constituent elements increases; fifthly, that the number of the constituent principles or components is not the only cause of the differences which distinguish compounds, but that the proportions in which these elements are united, and perhaps also the mode of their union, are other causes of these differences.

"Thus the whole doctrine of the pretended elements, or of the principles of things, or of their components, or of the compositions of different orders of compounds, is now reduced to conceptions as simple as they are precise. There are no hypotheses or useless distinctions or erroneous abstractions in the present ideas of chemists, and the obscurity which formerly reigned in this part of the science has wholly disappeared, and at the same time we have got rid of a source of vague and endless discussions. We have no longer to dwell in the schools on useless questions about a primitive matter and its relations; on whether there are four, three, two, or only a single element; on the pretended relations of the elements among themselves; on their transformation, or on the change of one into another. All these dreams of a sham speculative philosophy have vanished before the facts discovered by the experimental method; and the five propositions enunciated above, as simple as they are true, are data on which we can now securely build."

Turning, now, to Lavoisier's own "Traité élémentaire de Chimie," which must be regarded as the "Principia" of chemical science, we find, for the first time in the history of the subject, a list of twenty-five definite substances distinguished as elementary on the sole basis that they had as yet never been analyzed. This list is given in the first column of the table which we reproduce in translation on the following page, on account of its very great historical interest. Still, there is even here an obvious survival of Aristotle and the phlogiston theory, both in what the list includes and in what it omits. The first name on the list is caloric, and three of the other elements are the muriatic, fluoric, and boracic radicals, which, though not yet isolated, appear to Lavoisier so distinctly typified and foreshadowed that he does not hesitate to name them in this list. These radicals, it must be noticed, were radicals which, united to oxygen, would form respectively hydrochloric, hydrofluoric, and boracic acid, so that in the last case only were Lavoisier's expectations realized in the form which he expected. Indeed, the radical of muriatic acid, chlorine, was then a well-known substance, having been discovered by Scheele in 1774, but so little did it answer to the expected radical that it was regarded by Lavoisier as an oxide, and named by him "acide muriatique oxygéné," and under this name appears in this very table (translated oxidized muriatic acid). What we know as chlorine gas was classed by Lavoisier as the fourth degree of oxidation of his assumed muriatic radical, while muriatic acid itself was the

TABLE OF THE BINARY COMBINATIONS OF OXYGEN WITH OXIDABLE AND ACIDIFIABLE METALLIC AND NON-METALLIC SUBSTANCES.

	Combinations of oxygen with—	FIRST DEGREE OF OXIDATION.		SECOND DEGREE OF OXIDATION.		THIRD DEGREE OF OXIDATION.		FOURTH DEGREE OF OXIDAT'N.	
		New names.	Old names.	New names.	Old names.	New names.	Old names.	New names.	Old names.
Simple non-metallic substances.	Caloric	Oxygen gas.	Vital, or dephlogisticated air.						
	Hydrogen	We only know of one degree of combination of oxygen and hydrogen, and that combination forms water.							
	Nitrogen	Nitrous oxide, or base of the nitrous gas.	Nitrous gas.	Nitrous acid.	Fuming nitrous acid.	Nitric acid.	Non-fuming nitrous acid.	Oxidized nitric acid.	Unknown.
	Carbon	Oxide of carbon.	Unknown.	Carbonous acid.	Unknown.	Carbonic acid.	Fixed air.	Oxidized carbonic acid.	Unknown.
	Sulphur	Oxide of sulphur.	Soft sulphur.	Sulphurous acid.	Sulphurous acid.	Sulphuric acid.	Vitriolic acid.	Oxidized sulphuric acid.	Unknown.
	Phosphorus	Oxide of phosphorus.	Residue from the combustion of phosphorus.	Phosphorous acid.	Volatile acid of phosphorus.	Phosphoric acid.	Phosphoric acid	Oxidized phosphoric acid.	Unknown.
	The muriatic radical.	Muriatic oxide.	Unknown.	Muriatous acid.	Unknown.	Muriatic acid.	Marine acid.	Oxidized muriatic acid.	Dephlogistic'd marine acid.
	The fluoric radical.	Fluoric oxide.	Unknown.	Fluorous acid.	Unknown.	Fluoric acid.	Unknown to the ancients.		
	The boracic radical.	Boracic oxide.	Unknown.	Boracous acid.	Unknown.	Boracic acid.	Sedative salt of Homberg.		
Simple metallic substances.	Antimony	Gray oxide of antimony.	Gray calx of antimony.	White oxide of antimony.	White calx of antimony. Diaphoretic antimony.	Antimonic acid.			
	Silver	Oxide of silver.	Calx of silver.	......	......	Argentic acid.			
	Arsenic	Gray oxide of arsenic.	Gray calx of arsenic.	White oxide of arsenic.	White calx of arsenic.	Arsenic acid.	Arsenical acid.	Oxidized arsenic acid	Unknown.
	Bismuth	Gray oxide of bismuth.	Gray calx of bismuth.	White oxide of bismuth.	White calx of bismuth.	Bismuthic acid.			
	Cobalt	Gray oxide of cobalt.	Gray calx of cobalt	......	......	Cobaltic acid.			
	Copper	Reddish-brown oxide of copper.	Reddish-brown calx of copper.	Green and blue oxide of copper.	Green and blue calx of copper.	Cupric acid.			
	Tin	Gray oxide of tin.	Gray calx of tin.	White oxide of tin.	White calx of tin, or putty of tin.	Stannic acid.			
	Iron	Black oxide of iron.	Ethiops martial.	Yellow and red oxide of iron.	Ochre and rust.	Ferric acid.			
	Manganese	Black oxide of manganese.	Black calx of manganese.	White oxide of mang'nese	White calx of mang'ese	Manganic acid.			
	Mercury	Black oxide of mercury.	Ethiops mineral.	Yellow and red oxide of mercury.	Turbith mineral Red precipitate. Precipitate *per se*.	Mercuric acid.			
	Molybdenum	Oxide of molybdenum.	Calx of molybdenum.	......	......	Molybdic acid.	Acid of molybdenum.	Oxidized molybdic acid.	Unknown.
	Nickel	Oxide of nickel.	Calx of nickel.	......	......	Nickelic acid.			
	Gold	Yellow oxide of gold.	Yellow calx of gold.	Red oxide of gold.	Red calx of gold. Purple precipit. of Cassius.	Auric acid.			
	Platinum	Yellow oxide of platinum.	Yellow calx of platinum.	......	......	Platinic acid.			
	Lead	Gray oxide of lead.	Gray calx of lead.	Yellow and red oxide of lead.	Massicot and minium.	Plumbic acid.			
	Tungsten	Oxide of tungsten.	Calx of tungsten.	......	......	Tungstic acid.	Acid of tungst'n	Oxidized tungstic acid.	Unknown.
	Zinc	Gray oxide of zinc.	Gray calx of zinc.	White oxide of zinc.	White calx of zinc. Pompholix.				

third degree of oxidation of the same radical. It was left for Davy to demonstrate the elementary nature of chlorine and to discover the true relations of the hydrogen acids. Lavoisier regarded oxygen as the universal acidifying principle, and the facts known in his day admitted of this interpretation; and it is interesting to see how they were worked up in the table; but when a class of acids containing no oxygen came to be clearly recognized, they proved a serious embarrassment to the Lavoisierian system as it was developed by Berzelius and his associates.

With the exception of caloric and two of the radicals above referred to, Lavoisier's list of elements includes no substance not regarded as elementary at the present day; but the list is as remarkable for what it omits as for what it includes. There were then known, and had been known for a long time, two very well marked classes of bodies called alkalies and earths which readily combined with acids to form salts. In this respect these bodies closely resembled the known metallic oxides, as they did also in most cases in their general appearance, and they were classed by Lavoisier with the oxides under the general term of "bases salifiables." Still, they had never been decomposed, and, according to the spirit of Lavoisier's philosophy, ought to have been classed among elementary substances; but Lavoisier's classificatory instinct was altogether too acute to permit him to fall into any such error. He enumerates these bodies, and, although he speaks doubtfully in regard to them, he never for a moment questions their compound nature. In regard to the earths he says their composition is wholly unknown, implying, of course, that they were compounds, and under the head of "Des Substances métalliques" is this significant paragraph:

"It is probable that we only know a part of the metallic substances which exist in nature. All those, for example, which have more affinity for oxygen than for carbon can not be reduced or brought to a metallic state, and must appear to us as oxides which we mistake for earths. It is very probable that baryta, which we have classed as an earth, is a case in point. When experimented upon, it exhibits characters which closely approach those of metallic substances. It may be, indeed, that all the substances to which we give the name of earths are only metallic oxides that can not be reduced by the means which we use."

It will be noticed that the alkalies are not included under this remark, for their active qualities are very different from those of an insipid, earthy-looking, metallic oxide; and their resemblance to ammonia, the volatile alkali, a known compound of nitrogen, was constantly a confusing circumstance. Lavoisier discusses the question whether potash and soda pre-exist as such in the plants from whose ashes they are procured, and makes the suggestion that they may result from the combined action of the oxygen and nitrogen of the atmosphere on the organic materials in the process of burning. Fourcroy goes still further. In his work on "Chemical Philosophy," to which I have referred, he writes (translation):

"We do not understand the composition of potash. It has been suspected that it might result from a union of lime with nitrogen, because it is often found in vegetables mixed with this earth; but this theory, which I brought forward some fifteen years ago, has not been proved by any positive fact." It is interesting to go back and watch this groping in the dark for what is now positive knowledge, but the experience may teach us many a valuable lesson, and will at least help us to realize the intense enthusiasm with which, on October 6, 1807, Davy saw metallic globules running from a lump of caustic potash under the influence of the current of his new voltaic battery.

With this great achievement of Davy the formative period of the Lavoisierian system of chemistry may be said to have closed; but in this connection it is amusing to notice that in a chemical text-book studied in Harvard College by the class of 1815, and given me by the late Hon. John G. Palfrey, of that class, the alkalies and earths are included in the list of chemical elements, and Davy's discovery is only briefly referred to in a note.

Immediately after Davy's short but brilliant career, the science of chemistry took the form which it retained for nearly fifty years—a form in which it was first studied by all the older men of the present generation. The form was essentially that given by Lavoisier, and its chief merit was the simplicity of the classification, and the admirable nomenclature in which this classification was expressed. This nomenclature, which is to a great extent still retained, although the terms have lost most of their original significance, was devised by Lavoisier, with the co-operation of several of his associates, and adopted with the sanction of the French Academy of Sciences. It was a masterly production, and very greatly strengthened the hold which the system acquired at all the great centers of learning. The general features of the Lavoisierian system can be stated in few words.

Oxygen, which constitutes at least one half of the earth's crust, is the common cement by which all the elementary parts are held together. It is the universal acidifying principle, and the salifiable bases owe their peculiar relations to the same element as well. The elements may be divided into metals and non-metallic substances. The direct compounds of the non-metals with oxygen in different proportions are acids, while the compounds of the metals with oxygen are salifiable bases, and the compounds of the acids and bases are salts; and simple salts may still further combine with each other to form double salts. Thus, beginning with the elements, combination proceeded, pair and pair, until all terrestrial products were educed. The members of each class of these products were designated by specific names, regularly formed and easily remembered.

Such a simple system could easily be comprehended and presented in such works as that of the late Dr. Turner, and, illustrated by the brilliant phenomena of combustion, had a great charm. I can remember most distinctly the impression it made on me as a boy, and I have heard many learned men, among others my late colleague, Dr. Asa Gray, speak in the most glowing terms of the impression it made on them.

Lavoisier himself regarded his system as perfectly true to nature, and often affirms that he accepts no conclusion not based on experimental evidence; but, with the progress of knowledge, the system soon became highly artificial. Indeed, it never would have been formulated had not its author's vision been restricted to the narrow field that had been cultivated in his time. As investigation extended, the class of hydrogen acids, and their products, which Lavoisier had hidden away under a mistaken interpretation of their constitution, assume an ever-increasing prominence; and the system was doomed when Berzelius felt obliged to withdraw this class of bodies from the general scheme, and place them by themselves in a special division, which he called the *haloids*. Then after a time it appeared that the simple oxides of the elements had neither acid nor basic properties in themselves, and only acquired active qualities of either kind when united with water; and that hydrogen and not oxygen was the acidifying principle. Moreover, multitudes of compounds were discovered in whose production oxygen took no part whatever, and, although attempts were made to classify these on the same general dualistic plan, assuming that sulphur, chlorine, or one of the allied elements might act in place of oxygen as a general binding agent in a chemical combination, yet the attempts were obvious failures.

Before I became a teacher of chemistry, in 1849, it had already become evident that Lavoisier's definition of a chemical element, as a substance that could not be decomposed, must be modified; or, at least, that even if our actual processes of analysis could not go beyond the substances regarded as elementary, the philosophy could not possibly be thus restricted. Many facts previously known but overlooked, and other facts then first discovered which exhibited the old facts in a stronger light, all combined to show clearly that the same chemical element might appear under the guise of different substances. By burning a gem in oxygen gas, Davy had proved that diamond was pure carbon; and when it was also shown that the iron in graphite was an accidental impurity, it appeared that carbon was known under three forms, diamond, graphite, and charcoal. Sulphur, in like manner, was found to crystallize in two wholly incompatible forms, and under these different phases showing such marked differences of qualities that they must be regarded as distinct substances. In 1845 Schrötter proved that what had before been known as red phosphorus, and thought to be a lower oxide of the element, was in fact a different condition, an allotropic form, as it was then called, of pure phosphorus—a form which differs as widely from the wax-like, highly combustible material that is so well known as any two substances well could differ. A few years earlier Schönbein had discovered a new condition of oxygen, which he called *ozone*, differing widely from ordinary oxygen gas. Now, since all the forms of the same element yield the same products, and hence give the same chemical reactions, it became obvious, as such facts multiplied, that we may have different *substances* consisting wholly of the same chemical element; and hence that the chemical element, whatever it might be, could not be a definite substance, as Lavoisier had defined it.

Meanwhile another class of facts became prominent, chiefly in consequence of the investigations in organic chemistry to which Liebig had given such great impulse in Germany. Groups of compounds, consisting for the most part of carbon, hydrogen, and oxygen, came to be known, which, although having exactly the same composition (that is, formed by the union of the same elements in the same definite proportions), had, nevertheless, utterly different properties and relations. Such compounds are said to be isomeric, and a good example may be found in acetic ether, a very fragrant neutral spirit, and butyric acid, whose offensive odor and acrid taste are only too well known in rancid butter. But if oxygen is the acidifying principle of butyric acid, why does it not produce the same effect as an equal constituent of the ether? Similar phenomena of isomerism soon became very prominent, and forced on chemists the conviction, often against their prejudices, that the nature of the product depended not solely on the nature and proportions of the elements which entered into its composition, but quite as much, and even more, on the manner in which the constituents were combined.

To this phrase—the manner in which the constituents are combined—no definite meaning was at first attached; but the old atomic theory, first applied in chemistry by Dalton, was soon so modified as to give a form to the conception, and on the distinction between atoms and molecules then introduced the whole philosophy of modern chemistry rests.

In the subdivisions of material bodies, the molecules are the smallest masses in which the qualities of a substance inhere. A molecule of sugar or salt is simply a very small lump of sugar or salt in which all the qualities of sweetness or saltness are preserved. These molecules, however, although the elements of substances, are not the ultimate elements of matter, but on the contrary are themselves aggregates—often very complex aggregates—of still smaller units which are considered to be the elemental atoms. Of such atoms we must admit as many different kinds as we have distinguished chemical elements, and the atoms are for the present the ultimate limit of our analysis of matter. These atoms are now the ideal chemical elements. Starting from the atoms, the orders of combination are, first, the union of the atoms to form the molecules which are the nuclei of definite substances, then the aggregation of these molecules to form material masses.

Obviously we may conceive of the union of either similar or of dissimilar atoms; and while the union of unlike atoms results in the production of molecules of compound substances, the union of like atoms (all of oxygen or all of hydrogen, for example) yields molecules of elementary substances. So far as the primary structure is concerned, there is no distinction between an elementary substance like oxygen gas and a compound substance like water. In each case the material is an aggregate of similar molecules, and owes its physical qualities to the external relations of its peculiar units; but, while the molecules of oxygen gas are each composed of two atoms of oxygen, the molecules of water consist each of two atoms of hydrogen and one of oxygen.

In admitting the possibility of the union of similar atoms to form the molecules of elementary substances, the new philosophy of chemistry differs most markedly from the old. The system of Lavoisier was based on a conception of dualism originally suggested by sexual relations; and the term *elective affinity*, which was so constantly used to explain chemical changes, was a phase of this conception. The elements of two kinds paired together to form acids or bases, and the acids and bases paired to form salts, and chemical changes were the consequence of the superior affinity of another acid or another base for the temporary mate of a fellow-companion. At the time of Lavoisier, the grosser features of these dualistic conceptions, which so disgust us in the earlier writers on chemistry, had disappeared; and, still later, Berzelius attempted to place the system on a scientific basis by referring the dualism to electrical relations. But there was an entire continuity of thought from first to last, and in this was involved the prevailing idea that strength of chemical union depended on opposition of qualities. But this idea, which I have no doubt many scholars who studied chemistry under the old system still retain, was an entire misconception.

One of the strongest combining forces known to chemistry is that which holds together the dissimilar atoms of oxygen and hydrogen in the molecules of water, and, measured by the heat evolved, this force is nearly equaled by the force which unites the similar atoms of nitrogen to form a molecule of nitrogen gas; and the great violence of many modern explosives depends upon this circumstance.

It will now be seen that with our new philosophy the whole glamour which formerly bedazzled our idea of an elementary substance, and distinguished it widely from all other substances, disappears. The differences between substances depend upon the differences between their molecules, and as great molecular differences may arise from the union of similar as from the union of dissimilar atoms. The union of two atoms of hydrogen and one of oxygen gives a molecule of water, the union of two atoms of hydrogen and two of oxygen gives a molecule of peroxide of hydrogen; the union of two atoms of oxygen alone gives a molecule of oxygen gas, the union of three atoms of oxygen a molecule of ozone, and the difference between the last two substances is as great and of the same sort as the difference between the first two; and so it is with the so-called allotropic states of other elementary substances.

According to the modern philosophy of chemistry, the properties and relations of a substance depend fully as much upon the manner in which the atoms are grouped in the molecules of the substance as upon the nature of the atoms of which the molecules consist; and the differences between isomeric substances to which we have referred, depend wholly on what we call the molecular structure. The molecules, both of butyric acid and of acetic ether, consist of four atoms of carbon, eight atoms of hydrogen, and two of oxygen, and the chemist will show you just how these atoms are grouped in the molecule of each substance, and how the separate relations of these widely differing products depend on the structure he has assigned to their respective molecules. Indeed, the study of molecular structure—that is, of the mode of grouping of atoms in the molecules, especially in those of the compounds of carbon—has almost engrossed the attention of chemists for the past twenty-five years. An immense mass of facts and theories has been collected, and a symbolical method of representing the structure has been adopted, which, although highly conventional, must embody real truth, however dimly it may be now perceived; for the system has led to more, and more important, discoveries than any one of the dominant systems of science of the present day. The system has a great charm for students, and what is called the study of organic chemistry in our colleges is wholly a discussion of problems of this kind.

These systems of atoms that we call molecules have been frequently compared to the solar system, and cited as evidence that man occupies an intermediate position in creation, with a microcosmos beneath as far removed from the order of his perceptions as is the macrocosmos above him. To one who realizes what must be the complex dynamical relations as well as the order of magnitude of these molecular systems, the diagrams of molecular structure which may be seen in any work on organic chemistry can not but appear as crude and childish as the figures of constellations on a celestial globe; and when, as frequently happens, the student confounds the sign and the substance, one can hardly refrain from a little good-natured laugh at the spider-leg formulæ, as a noted German chemist is in the habit of calling them. Still, these are only the conventional forms of a good working theory, which is a noble product of human thought and an effective means of advancing knowledge.

For one who has followed the history of chemical thought from the first, it is easy to discover great imperfections in our present system. The assumption that, with more than seventy different kinds of atoms already known, uniting in such varied combinations to form molecules, only like molecules should ever aggregate to form material masses, is a solecism in the very postulates of the system; and the whole question of molecular combination is one which is still in abeyance. Analogy forbids us to believe that, down to a certain limit of dimensions that we call molecules, the constitution of matter is of a wholly different sort from that which appears on subdividing the molecules. It is an equally incredible assumption that all atoms of the same element are so many independent creations exactly alike in every respect. Then, as our knowledge increases, the distinctions between the chemical elements are becoming less marked and their relations to each other more intimate. They are beginning to appear, not as isolated units, but as links in a complex network, which presents an unbroken continuity throughout. The recent study of the rarer earths leaves us in doubt whether we have an indefinite number of elements, or only one under unnumbered manifestations; and the later results of spectrum analysis seem to indicate quite clearly that, at the high temperatures of the sun and of the fixed stars, many of our terrestrial elements are decomposed. From a mathematical analysis of the spectra, Grünwald maintains—and supports his conclusion by a great array of confirmatory measurements—that the remarkable solar spectrum line called helium, and the equally well-marked line of the sun's corona, come from two constituents of hydrogen gas, the first of which is somewhat heavier and the last far lighter than hydrogen gas; and this conclusion, if not finally accepted, is regarded as highly probable by men of such scientific sobriety as Liveing and Dewar, of Cambridge, in England—men who are acknowledged as among the best authorities on spectrum analysis. I had intended, in this connection, to discuss these last points, to which I can here only allude, and which are every day acquiring greater and greater importance; but my paper is already too long, and there is abundant material for another essay on the same general subject. I have accomplished the immediate object at which I aimed, if I have made evident that the foundations of our science are still hidden in obscurity, and that the conception of a chemical element is to-day just as indefinite and just as metaphysical as it was at the time of Aristotle.

AGNOSTICISM.

By Prof. THOMAS H. HUXLEY.

WITHIN the last few months the public has received much and varied information on the subject of agnostics, their tenets, and even their future. Agnosticism exercised the orators of the Church Congress at Manchester.* It has been furnished with a set of "articles" fewer, but not less rigid, and certainly not less consistent than the thirty-nine; its nature has been analyzed, and its future severely predicted by the most eloquent of that prophetical school whose Samuel is Auguste Comte. It may still be a question, however, whether the public is as much the wiser as might be expected, considering all the trouble that has been taken to enlighten it. Not only are the three accounts of the agnostic position sadly out of harmony with one another, but I propose to show cause for my belief that all three must be seriously questioned by any one who employs the term "agnostic" in the sense in which it was originally used. The learned principal of King's College, who brought the topic of agnosticism before the Church Congress, took a short and easy way of settling the business:

> But if this be so, for a man to urge, as an escape from this article of belief, that he has no means of a scientific knowledge of the unseen world, or of the future, is irrelevant. His difference from Christians lies not in the fact that he has no knowledge of these things, but that he does not believe the authority on which they are stated. He may prefer to call himself an agnostic; but his real name is an older one—he is an infidel; that is to say, an unbeliever. The word infidel, perhaps, carries an unpleasant significance. Perhaps it is right that it should. It is, and it ought to be, an unpleasant thing for a man to have to say plainly that he does not believe in Jesus Christ.

And in the course of the discussion which followed, the Bishop of

* See the "Official Report of the Church Congress held at Manchester," October, 1888, pp. 253, 254.

Peterborough departed so far from his customary courtesy and self-respect as to speak of "cowardly agnosticism" (p. 262).

So much of Dr. Wace's address either explicitly or implicitly concerns me, that I take upon myself to deal with it; but, in so doing, it must be understood that I speak for myself alone; I am not aware that there is any sect of Agnostics; and if there be, I am not its acknowledged prophet or pope. I desire to leave to the Comtists the entire monopoly of the manufacture of imitation ecclesiasticism.

Let us calmly and dispassionately consider Dr. Wace's appreciation of agnosticism. The agnostic, according to his view, is a person who says he has no means of attaining a scientific knowledge of the unseen world or of the future; by which somewhat loose phraseology Dr. Wace presumably means the theological unseen world and future. I can not think this description happy either in form or substance, but for the present it may pass. Dr. Wace continues, that is not "his difference from Christians." Are there, then, any Christians who say that they know nothing about the unseen world and the future? I was ignorant of the fact, but I am ready to accept it on the authority of a professional theologian, and I proceed to Dr. Wace's next proposition.

The real state of the case, then, is that the agnostic "does not believe the authority" on which "these things" are stated, which authority is Jesus Christ. He is simply an old-fashioned "infidel" who is afraid to own to his right name. As "Presbyter is priest writ large," so is "agnostic" the mere Greek equivalent for the Latin "infidel." There is an attractive simplicity about this solution of the problem; and it has that advantage of being somewhat offensive to the persons attacked, which is so dear to the less refined sort of controversialist. The agnostic says, "I can not find good evidence that so and so is true." "Ah," says his adversary, seizing his opportunity, "then you declare that Jesus Christ was untruthful, for he said so and so"; a very telling method of rousing prejudice. But suppose that the value of the evidence as to what Jesus may have said and done, and as to the exact nature and scope of his authority, is just that which the agnostic finds it most difficult to determine? If I venture to doubt that the Duke of Wellington gave the command, "Up, Guards, and at 'em!" at Waterloo, I do not think that even Dr. Wace would accuse me of disbelieving the duke. Yet it would be just as reasonable to do this as to accuse any one of denying what Jesus said before the preliminary question as to what he did say is settled.

Now, the question as to what Jesus really said and did is strictly a scientific problem, which is capable of solution by no other methods than those practiced by the historian and the literary critic. It is a problem of immense difficulty, which has occupied some of the best heads in Europe for the last century; and it is only of late years that their investigations have begun to converge toward one conclusion.*

That kind of faith which Dr. Wace describes and lauds is of no use here. Indeed, he himself takes pains to destroy its evidential value.

"What made the Mohammedan world? Trust and faith in the declarations and assurances of Mohammed. And what made the Christian world? Trust and faith in the declarations and assurances of Jesus Christ and his apostles" (*loc. cit.*, p. 253). The triumphant tone of this imaginary catechism leads me to suspect that its author has hardly appreciated its full import. Presumably, Dr. Wace regards Mohammed as an unbeliever, or, to use the term which he prefers, infidel; and considers that his assurances have given rise to a vast delusion, which has led, and is leading, millions of men straight to everlasting punishment. And this being so, the "trust and faith" which have "made the Mohammedan world," in just the same sense as they have "made the Christian world," must be trust and faith in falsehood. No man who has studied history, or even attended to the occurrences of every-day life, can doubt the enormous practical value of trust and faith; but as little will he be inclined to deny that this practical value has not the least relation to the reality of the objects of that trust and faith. In examples of patient constancy of faith and of unswerving trust, the "Acta Martyrum" do not excel the annals of Babism.

The discussion upon which we have now entered goes so thoroughly to the root of the whole matter; the question of the day is so completely, as the author of "Robert Elsmere" says, the value of testimony, that I shall offer no apology for following it out somewhat in detail; and, by way of giving substance to the argument, I shall base what I have to say upon a case, the consideration of which lies strictly within the province of natural science, and of that particular part of it known as the physiology and pathology of the nervous system.

* Dr. Wace tells us, "It may be asked how far we can rely on the accounts we possess of our Lord's teaching on these subjects." And he seems to think the question appropriately answered by the assertion that it "ought to be regarded as settled by M. Renan's practical surrender of the adverse case." I thought I knew M. Renan's works pretty well, but I have contrived to miss this "practical" (I wish Dr. Wace had defined the scope of that useful adjective) surrender. However, as Dr. Wace can find no difficulty in pointing out the passage of M. Renan's writings, by which he feels justified in making his statement, I shall wait for further enlightenment, contenting myself, for the present, with remarking that if M. Renan were to retract and do penance in Notre Dame to-morrow for any contributions to Biblical criticism that may be specially his property, the main results of that criticism, as they are set forth in the works of Strauss, Baur, Reuss, and Volkmar, for example, would not be sensibly affected.

I find, in the second Gospel (chap. v), a statement, to all appearance intended to have the same evidential value as any other contained in that history. It is the well-known story of the devils who were cast out of a man, and ordered, or permitted, to enter into a herd of swine, to the great loss and damage of the innocent Gerasene, or Gadarene, pig-owners. There can be no doubt that the narrator intends to convey to his readers his own conviction that this casting out and entering in were effected by the agency of Jesus of Nazareth; that, by speech and action, Jesus enforced this conviction; nor does any inkling of the legal and moral difficulties of the case manifest itself.

On the other hand, everything that I know of physiological and pathological science leads me to entertain a very strong conviction that the phenomena ascribed to possession are as purely natural as those which constitute small-pox; everything that I know of anthropology leads me to think that the belief in demons and demoniacal possession is a mere survival of a once universal superstition, and that its persistence at the present time is pretty much in the inverse ratio of the general instruction, intelligence, and sound judgment of the population among whom it prevails. Everything that I know of law and justice convinces me that the wanton destruction of other people's property is a misdemeanor of evil example. Again, the study of history, and especially of that of the fifteenth, sixteenth, and seventeenth centuries, leaves no shadow of doubt on my mind that the belief in the reality of possession and of witchcraft, justly based, alike by Catholics and Protestants, upon this and innumerable other passages in both the Old and New Testaments, gave rise, through the special influence of Christian ecclesiastics, to the most horrible persecutions and judicial murders of thousands upon thousands of innocent men, women, and children. And when I reflect that the record of a plain and simple declaration upon such an occasion as this, that the belief in witchcraft and possession is wicked nonsense, would have rendered the long agony of mediæval humanity impossible, I am prompted to reject, as dishonoring, the supposition that such declaration was withheld out of condescension to popular error.

"Come forth, thou unclean spirit, out of the man" (Mark v, 8),* are the words attributed to Jesus. If I declare, as I have no hesitation in doing, that I utterly disbelieve in the existence of "unclean spirits," and, consequently, in the possibility of their "coming forth" out of a man, I suppose that Dr. Wace will tell me I am disregarding the "testimony of our Lord" (*loc. cit.*, p. 255). For if these words were really used, the most resourceful of reconcilers can hardly venture to affirm that they are compatible with

* Here, as always, the revised version is cited.

a disbelief in "these things." As the learned and fair-minded, as well as orthodox, Dr. Alexander remarks, in an editorial note to the article "Demoniacs," in the "Biblical Cyclopædia" (vol. i, p. 664, note):

> . . . . On the lowest grounds on which our Lord and his apostles can be placed, they must, at least, be regarded as *honest* men. Now, though honest speech does not require that words should be used always and only in their etymological sense, it does require that they should not be used so as to affirm what the speaker knows to be false. While, therefore, our Lord and his apostles might use the word δαιμονίζεσθαι, or the phrase δαιμόνιον ἔχειν, as a popular description of certain diseases, without giving in to the belief which lay at the source of such a mode of expression, they could not speak of demons entering into a man, or being cast out of him, without pledging themselves to the belief of an actual possession of the man by the demons (Campbell, "Prel. Diss.," vi, 1, 10). If, consequently, they did not hold this belief, they spoke not as honest men.

The story which we are considering does not rest on the authority of the second Gospel alone. The third confirms the second, especially in the matter of commanding the unclean spirit to come out of the man (Luke viii, 29); and, although the first Gospel either gives a different version of the same story, or tells another of like kind, the essential point remains: "If thou cast us out, send us away into the herd of swine. And he said unto them, Go!" (Matthew viii, 31, 32).

If the concurrent testimony of the three synoptics, then, is really sufficient to do away with all rational doubt as to a matter of fact of the utmost practical and speculative importance—belief or disbelief in which may affect, and has affected, men's lives and their conduct toward other men in the most serious way—then I am bound to believe that Jesus implicitly affirmed himself to possess a "knowledge of the unseen world," which afforded full confirmation to the belief in demons and possession current among his contemporaries. If the story is true, the mediæval theory of the invisible world may be, and probably is, quite correct; and the witch-finders, from Sprenger to Hopkins and Mather, are much-maligned men.

On the other hand, humanity, noting the frightful consequences of this belief; common sense, observing the futility of the evidence on which it is based, in all cases that have been properly investigated; science, more and more seeing its way to inclose all the phenomena of so-called "possession" within the domain of pathology, so far as they are not to be relegated to that of the police—all these powerful influences concur in warning us, at our peril, against accepting the belief without the most careful scrutiny of the authority on which it rests.

I can discern no escape from this dilemma: either Jesus said what he is reported to have said, or he did not. In the former case, it is inevitable that his authority on matters connected with the "unseen world" should be roughly shaken; in the latter, the blow falls upon the authority of the synoptic gospels. If their report on a matter of such stupendous and far-reaching practical import as this is untrustworthy, how can we be sure of its trustworthiness in other cases? The favorite "earth," in which the hard-pressed reconciler takes refuge, that the Bible does not profess to teach science,* is stopped in this instance. For the question of the existence of demons and of possession by them, though it lies strictly within the province of science, is also of the deepest moral and religious significance. If physical and mental disorders are caused by demons, Gregory of Tours and his contemporaries rightly considered that relics and exorcists were more useful than doctors; the gravest questions arise as to the legal and moral responsibilities of persons inspired by demoniacal impulses; and our whole conception of the universe and of our relations to it becomes totally different from what it would be on the contrary hypothesis.

The theory of life of an average mediæval Christian was as different from that of an average nineteenth-century Englishman as that of a West-African negro is now in these respects. The modern world is slowly, but surely, shaking off these and other monstrous survivals of savage delusions, and, whatever happens, it will not return to that wallowing in the mire. Until the contrary is proved, I venture to doubt whether, at this present moment, any Protestant theologian, who has a reputation to lose, will say that he believes the Gadarene story.

The choice then lies between discrediting those who compiled the gospel biographies and disbelieving the Master, whom they, simple souls, thought to honor by preserving such traditions of the exercise of his authority over Satan's invisible world. This is the dilemma. No deep scholarship, nothing but a knowledge of the revised version (on which it is to be supposed all that mere scholarship can do has been done), with the application thereto of the commonest canons of common sense, is needful to enable us to make a choice between its horns. It is hardly doubtful that the

* Does any one really mean to say that there is any internal or external criterion by which the reader of a biblical statement, in which scientific matter is contained, is enabled to judge whether it is to be taken *au sérieux* or not? Is the account of the Deluge, accepted as true in the New Testament, less precise and specific than that of the call of Abraham, also accepted as true therein? By what mark does the story of the feeding with manna in the wilderness, which involves some very curious scientific problems, show that it is meant merely for edification, while the story of the inscription of the law on stone by the hand of Jahveh is literally true? If the story of the Fall is not the true record of an historical occurrence, what becomes of Pauline theology? Yet the story of the Fall as directly conflicts with probability, and is as devoid of trustworthy evidence, as that of the Creation or that of the Deluge, with which it forms an harmoniously legendary series.

story, as told in the first Gospel, is merely a version of that told in the second and third. Nevertheless, the discrepancies are serious and irreconcilable; and, on this ground alone, a suspension of judgment, at the least, is called for. But there is a great deal more to be said. From the dawn of scientific biblical criticism until the present day the evidence against the long-cherished notion that the three synoptic gospels are the works of three independent authors, each prompted by divine inspiration, has steadily accumulated, until, at the present time, there is no visible escape from the conclusion that each of the three is a compilation consisting of a groundwork common to all three—the threefold tradition; and of a superstructure, consisting, firstly, of matter common to it with one of the others, and, secondly, of matter special to each. The use of the terms "groundwork" and "superstructure" by no means implies that the latter must be of later date than the former. On the contrary, some parts of it may be, and probably are, older than some parts of the groundwork.*

The story of the Gadarene swine belongs to the groundwork; at least, the essential part of it, in which the belief in demoniac possession is expressed, does; and therefore the compilers of the first, second, and third gospels, whoever they were, certainly accepted that belief (which, indeed, was universal among both Jews and pagans at that time), and attributed it to Jesus.

What, then, do we know about the originator, or originators, of this groundwork—of that threefold tradition which all three witnesses (in Paley's phrase) agree upon—that we should allow their mere statements to outweigh the counter-arguments of humanity, of common sense, of exact science, and to imperil the respect which all would be glad to be able to render to their Master?

Absolutely nothing.† There is no proof, nothing more than a fair presumption, that any one of the gospels existed, in the state in which we find it in the authorized version of the Bible, before the second century, or, in other words, sixty or seventy years after the events recorded. And, between that time and the date of the oldest extant manuscripts of the Gospels, there is no telling what additions and alterations and interpolations may have been made. It may be said that this is all mere speculation, but it is a good

* See, for an admirable discussion of the whole subject, Dr. Abbott's article on the Gospels in the "Encyclopædia Britannica"; and the remarkable monograph by Prof. Volkmar, "Jesus Nazarenus und die erste christliche Zeit" (1882). Whether we agree with the conclusions of these writers or not, the method of critical investigation which they adopt is unimpeachable.

† Notwithstanding the hard words shot at me from behind the hedge of anonymity by a writer in a recent number of the "Quarterly Review," I repeat, without the slightest fear of refutation, that the four Gospels, as they have come to us, are the work of unknown writers.

deal more. As competent scholars and honest men, our revisers have felt compelled to point out that such things have happened even since the date of the oldest known manuscripts. The oldest two copies of the second Gospel end with the eighth verse of the sixteenth chapter; the remaining twelve verses are spurious, and it is noteworthy that the maker of the addition has not hesitated to introduce a speech in which Jesus promises his disciples that "in my name shall they cast out devils."

The other passage "rejected to the margin" is still more instructive. It is that touching apologue, with its profound ethical sense, of the woman taken in adultery—which, if internal evidence were an infallible guide, might well be affirmed to be a typical example of the teachings of Jesus. Yet, say the revisers, pitilessly, "Most of the ancient authorities omit John vii, 53, viii, 11." Now, let any reasonable man ask himself this question: If, after an approximative settlement of the canon of the New Testament, and even later than the fourth and fifth centuries, literary fabricators had the skill and the audacity to make such additions and interpolations as these, what may they have done when no one had thought of a canon; when oral tradition, still unfixed, was regarded as more valuable than such written records as may have existed in the latter portion of the first century? Or, to take the other alternative, if those who gradually settled the canon did not know of the existence of the oldest codices which have come down to us; or if, knowing them, they rejected their authority, what is to be thought of their competency as critics of the text?

People who object to free criticism of the Christian Scriptures forget that they are what they are in virtue of very free criticism; unless the advocates of inspiration are prepared to affirm that the majority of influential ecclesiastics during several centuries were safeguarded against error. For, even granting that some books of the period were inspired, they were certainly few among many; and those who selected the canonical books, unless they themselves were also inspired, must be regarded in the light of mere critics, and, from the evidence they have left of their intellectual habits, very uncritical critics. When one thinks that such delicate questions as those involved fell into the hands of men like Papias (who believed in the famous millenarian grape story); of Irenæus with his "reasons" for the existence of only four Gospels; and of such calm and dispassionate judges as Tertullian, with his "*Credo quia impossibile*," the marvel is that the selection which constitutes our New Testament is as free as it is from obviously objectionable matter. The apocryphal Gospels certainly deserve to be apocryphal; but one may suspect that a little more critical discrimination would have enlarged the Apocrypha not inconsiderably.

At this point a very obvious objection arises and deserves full and candid consideration. It may be said that critical skepticism carried to the length suggested is historical pyrrhonism; that if we are to altogether discredit an ancient or a modern historian, because he has assumed fabulous matter to be true, it will be as well to give up paying any attention to history. It may be said, and with great justice, that Eginhard's "Life of Charlemagne" is none the less trustworthy because of the astounding revelation of credulity, of lack of judgment, and even of respect for the eighth commandment, which he has unconsciously made in the "History of the Translation of the Blessed Martyrs Marcellinus and Paul." Or, to go no further back than the last number of this review, surely that excellent lady, Miss Strickland, is not to be refused all credence because of the myth about the second James's remains, which she seems to have unconsciously invented.

Of course this is perfectly true. I am afraid there is no man alive whose witness could be accepted, if the condition precedent were proof that he had never invented and promulgated a myth. In the minds of all of us there are little places here and there, like the indistinguishable spots on a rock which give foothold to moss or stone-crop; on which, if the germ of a myth fall, it is certain to grow, without in the least degree affecting our accuracy or truthfulness elsewhere. Sir Walter Scott knew that he could not repeat a story without, as he said, "giving it a new hat and stick." Most of us differ from Sir Walter only in not knowing about this tendency of the mythopœic faculty to break out unnoticed. But it is also perfectly true that the mythopœic faculty is not equally active on all minds, nor in all regions and under all conditions of the same mind. David Hume was certainly not so liable to temptation as the Venerable Bede, or even as some recent historians who could be mentioned; and the most imaginative of debtors, if he owes five pounds, never makes an obligation to pay a hundred out of it. The rule of common sense is *prima facie* to trust a witness in all matters in which neither his self-interest, his passions, his prejudices, nor that love of the marvelous, which is inherent to a greater or less degree in all mankind, are strongly concerned; and, when they are involved, to require corroborative evidence in exact proportion to the contravention of probability by the thing testified.

Now, in the Gadarene affair, I do not think I am unreasonably skeptical if I say that the existence of demons who can be transferred from a man to a pig does thus contravene probability. Let me be perfectly candid. I admit I have no *a priori* objection to offer. There are physical things, such as *tæniæ* and *trichinæ*, which can be transferred from men to pigs, and *vice versa*, and which do undoubtedly produce most diabolical and deadly effects on both. For anything I can absolutely prove to the contrary, there may be spiritual things capable of the same transmigration, with like effects. Moreover, I am bound to add that perfectly truthful persons, for whom I have the greatest respect, believe in stories about spirits of the present day, quite as improbable as that we are considering.

So I declare, as plainly as I can, that I am unable to show cause why these transferable devils should not exist; nor can I deny that, not merely the whole Roman Church, but many Wacean "infidels" of no mean repute, do honestly and firmly believe that the activity of such-like demonic beings is in full swing in this year of grace 1889.

Nevertheless, as good Bishop Butler says, "probability is the guide of life," and it seems to me that this is just one of the cases in which the canon of credibility and testimony, which I have ventured to lay down, has full force. So that, with the most entire respect for many (by no means for all) of our witnesses for the truth of demonology, ancient and modern, I conceive their evidence on this particular matter to be ridiculously insufficient to warrant their conclusion.*

After what has been said I do not think that any sensible man, unless he happen to be angry, will accuse me of "contradicting the Lord and his apostles" if I reiterate my total disbelief in the whole Gadarene story. But, if that story is discredited, all the other stories of demoniac possession fall under suspicion. And if the belief in demons and demoniac possession, which forms the somber background of the whole picture of primitive Christianity presented to us in the New Testament, is shaken, what is to be said, in any case, of the uncorroborated testimony of the Gospels with respect to "the unseen world"?

I am not aware that I have been influenced by any more bias in regard to the Gadarene story than I have been in dealing with other cases of like kind the investigation of which has interested me. I was brought up in the strictest school of evangelical orthodoxy; and, when I was old enough to think for myself, I started

* Their arguments, in the long run, are always reducible to one form. Otherwise trustworthy witnesses affirm that such and such events took place. These events are inexplicable, except the agency of "spirits" is admitted. Therefore "spirits" were the cause of the phenomena.

And the heads of the reply are always the same. Remember Goethe's aphorism: "Alles factische ist schon Theorie." Trustworthy witnesses are constantly deceived, or deceive themselves, in their interpretation of sensible phenomena. No one can prove that the sensible phenomena, in these cases, could be caused only by the agency of spirits; and there is abundant ground for believing that they may be produced in other ways.

Therefore, the utmost that can be reasonably asked for, on the evidence as it stands, is suspension of judgment. And, on the necessity for even that suspension, reasonable men may differ, according to their views of probability.

upon my journey of inquiry with little doubt about the general truth of what I had been taught; and with that feeling of the unpleasantness of being called an "infidel" which, we are told, is so right and proper. Near my journey's end, I find myself in a condition of something more than mere doubt about these matters.

In the course of other inquiries, I have had to do with fossil remains which looked quite plain at a distance, and became more and more indistinct as I tried to define their outline by close inspection. There was something there—something which, if I could win assurance about it, might mark a new epoch in the history of the earth; but, study as long as I might, certainty eluded my grasp. So has it been with me in my efforts to define the grand figure of Jesus as it lies in the primary strata of Christian literature. Is he the kindly, peaceful Christ depicted in the Catacombs? Or is he the stern judge who frowns above the altar of SS. Cosmas and Damianus? Or can he be rightly represented in the bleeding ascetic, broken down by physical pain, of too many mediæval pictures? Are we to accept the Jesus of the second, or the Jesus of the fourth Gospel, as the true Jesus? What did he really say and do; and how much that is attributed to him in speech and action is the embroidery of the various parties into which his followers tended to split themselves within twenty years of his death, when even the threefold tradition was only nascent?

If any one will answer these questions for me with something more to the point than feeble talk about the "cowardice of agnosticism," I shall be deeply his debtor. Unless and until they are satisfactorily answered, I say of agnosticism in this matter, "*J'y suis, et j'y reste.*"

But, as we have seen, it is asserted that I have no business to call myself an agnostic; that if I am not a Christian I am an infidel; and that I ought to call myself by that name of "unpleasant significance." Well, I do not care much what I am called by other people, and, if I had at my side all those who since the Christian era have been called infidels by other folks, I could not desire better company. If these are my ancestors, I prefer, with the old Frank, to be with them wherever they are. But there are several points in Dr. Wace's contention which must be eliminated before I can even think of undertaking to carry out his wishes. I must, for instance, know what a Christian is. Now what is a Christian? By whose authority is the signification of that term defined? Is there any doubt that the immediate followers of Jesus, the "sect of the Nazarenes," were strictly orthodox Jews, differing from other Jews not more than the Sadducees, the Pharisees, and the Essenes differed from one another; in fact, only in the belief that the Messiah, for whom the rest of their nation waited, had come? Was not their chief, "James, the brother of the Lord," reverenced alike by Sadducee, Pharisee, and Nazarene? At the famous conference which, according to the Acts, took place at Jerusalem, does not James declare that "myriads" of Jews, who, by that time had become Nazarenes, were "all zealous for the law"? Was not the name of "Christian" first used to denote the converts to the doctrine promulgated by Paul and Barnabas at Antioch? Does the subsequent history of Christianity leave any doubt that, from this time forth, the "little rift within the lute," caused by the new teaching developed, if not inaugurated, at Antioch, grew wider and wider, until the two types of doctrine irreconcilably diverged? Did not the primitive Nazarenism or Ebionism develop into the Nazarenism, and Ebionism, and Elkasaitism of later ages, and finally die out in obscurity and condemnation as damnable heresy; while the younger doctrine throve and pushed out its shoots into that endless variety of sects, of which the three strongest survivors are the Roman and Greek Churches and modern Protestantism?

Singular state of things! If I were to profess the doctrine which was held by "James, the brother of the Lord," and by every one of the "myriads" of his followers and co-religionists in Jerusalem up to twenty or thirty years after the crucifixion (and one knows not how much later at Pella), I should be condemned with unanimity as an ebionizing heretic by the Roman, Greek, and Protestant Churches! And, probably, this hearty and unanimous condemnation of the creed held by those who were in the closest personal relation with their Lord is almost the only point upon which they would be cordially of one mind. On the other hand—though I hardly dare imagine such a thing—I very much fear that the "pillars" of the primitive Hierosolymitan Church would have considered Dr. Wace an infidel. No one can read the famous second chapter of Galatians and the book of Revelation without seeing how narrow was even Paul's escape from a similar fate. And, if ecclesiastical history is to be trusted, the thirty-nine articles, be they right or wrong, diverge from the primitive doctrine of the Nazarenes vastly more than even Pauline Christianity did.

But, further than this, I have great difficulty in assuring myself that even James, "the brother of the Lord," and his "myriads" of Nazarenes, properly represented the doctrines of their Master. For it is constantly asserted by our modern "pillars" that one of the chief features of the work of Jesus was the instauration of religion by the abolition of what our sticklers for articles and liturgies, with unconscious humor, call the narrow restrictions of the law. Yet, if James knew this, how could the bitter controversy with Paul have arisen; and why did one or the other side not quote any of the various sayings of Jesus, recorded in the Gospels, which directly bear on the question—sometimes, apparently, in opposite directions?

So, if I am asked to call myself an "infidel," I reply, To what doctrine do you ask me to be faithful? Is it that contained in the Nicene and the Athanasian Creeds? My firm belief is that the Nazarenes, say of the year 40, headed by James, would have stopped their ears and thought worthy of stoning the audacious man who propounded it to them. Is it contained in the so-called Apostles' Creed? I am pretty sure that even that would have created a recalcitrant commotion at Pella in the year 70, among the Nazarenes of Jerusalem, who had fled from the soldiers of Titus. And yet if the unadulterated tradition of the teachings of "the Nazarene" were to be found anywhere, it surely should have been amid those not very aged disciples who may have heard them as they were delivered.

Therefore, however sorry I may be to be unable to demonstrate that, if necessary, I should not be afraid to call myself an "infidel," I can not do it, even to gratify the Bishop of Peterborough and Dr. Wace. And I would appeal to the bishop, whose native sense of humor is not the least marked of his many excellent gifts and virtues, whether asking a man to call himself an "infidel" is not rather a droll request. "Infidel" is a term of reproach, which Christians and Mohammedans, in their modesty, agree to apply to those who differ from them. If he had only thought of it, Dr. Wace might have used the term "miscreant," which, with the same etymological signification, has the advantage of being still more "unpleasant" to the persons to whom it is applied. But, in the name of all that is Hibernian, I ask the Bishop of Peterborough why should a man be expected to call himself a "miscreant" or an "infidel"? That St. Patrick "had two birthdays because he was a twin" is a reasonable and intelligible utterance beside that of the man who should declare himself to be an infidel on the ground of denying his own belief. It may be logically, if not ethically, defensible that a Christian should call a Mohammedan an infidel, and *vice versa*; but, on Dr. Wace's principles, both ought to call themselves infidels, because each applies that term to the other.

Now I am afraid that all the Mohammedan world would agree in reciprocating that appellation to Dr. Wace himself. I once visited the Hazar Mosque, the great university of Mohammedanism, in Cairo, in ignorance of the fact that I was unprovided with proper authority. A swarm of angry undergraduates, as I suppose I ought to call them, came buzzing about me and my guide; and, if I had known Arabic, I suspect that "dog of an infidel" would have been by no means the most "unpleasant" of the epithets showered upon me, before I could explain and apologize for the mistake. If I had had the pleasure of Dr. Wace's company on that occasion, the undiscriminative followers of the Prophet would, I am afraid, have made no difference between us; not even if they had known that he was the head of an orthodox Christian seminary. And I have not the smallest doubt that even one of the learned mollahs, if his grave courtesy would have permitted him to say anything offensive to men of another mode of belief, would have told us that he wondered we did not find it "very unpleasant" to disbelieve in the Prophet of Islam.

From what precedes, I think it becomes sufficiently clear that Dr. Wace's account of the origin of the name of "Agnostic" is quite wrong. Indeed, I am bound to add that very slight effort to discover the truth would have convinced him that, as a matter of fact, the term arose otherwise. I am loath to go over an old story once more; but more than one object which I have in view will be served by telling it a little more fully than it has yet been told.

Looking back nearly fifty years, I see myself as a boy, whose education had been interrupted, and who, intellectually, was left, for some years, altogether to his own devices. At that time, I was a voracious and omnivorous reader; a dreamer and speculator of the first water, well endowed with that splendid courage in attacking any and every subject, which is the blessed compensation of youth and inexperience. Among the books and essays, on all sorts of topics from metaphysics to heraldry, which I read at this time, two left indelible impressions on my mind. One was Guizot's "History of Civilization," the other was Sir William Hamilton's essay "On the Philosophy of the Unconditioned," which I came upon, by chance, in an odd volume of the "Edinburgh Review." The latter was certainly strange reading for a boy, and I could not possibly have understood a great deal of it;* nevertheless, I devoured it with avidity, and it stamped upon my mind the strong conviction that, on even the most solemn and important of questions, men are apt to take cunning phrases for answers; and that the limitation of our faculties, in a great number of cases, renders real answers to such questions, not merely actually impossible, but theoretically inconceivable.

Philosophy and history having laid hold of me in this eccentric fashion, have never loosened their grip. I have no pretension to be an expert in either subject; but the turn for philosophical and historical reading, which rendered Hamilton and Guizot attractive to me, has not only filled many lawful leisure hours, and

* Yet I must somehow have laid hold of the pith of the matter, for, many years afterward, when Dean Mansell's Bampton lectures were published, it seemed to me I already knew all that this eminently agnostic thinker had to tell me.

still more sleepless ones, with the repose of changed mental occupation, but has not unfrequently disputed my proper work-time with my liege lady, Natural Science. In this way I have found it possible to cover a good deal of ground in the territory of philosophy; and all the more easily that I have never cared much about A's or B's opinions, but have rather sought to know what answer he had to give to the questions I had to put to him—that of the limitation of possible knowledge being the chief. The ordinary examiner, with his "State the views of So-and-so," would have floored me at any time. If he had said, "What do *you* think about any given problem?" I might have got on fairly well.

The reader who has had the patience to follow the enforced, but unwilling, egotism of this veritable history (especially if his studies have led him in the same direction), will now see why my mind steadily gravitated toward the conclusions of Hume and Kant, so well stated by the latter in a sentence, which I have quoted elsewhere:

"The greatest and perhaps the sole use of all philosophy of pure reason is, after all, merely negative, since it serves not as an organon for the enlargement [of knowledge], but as a discipline for its delimitation; and, instead of discovering truth, has only the modest merit of preventing error." *

When I reached intellectual maturity and began to ask myself whether I was an atheist, a theist, or a pantheist; a materialist or an idealist; a Christian or a freethinker—I found that the more I learned and reflected, the less ready was the answer; until, at last, I came to the conclusion that I had neither art nor part with any of these denominations, except the last. The one thing in which most of these good people were agreed was the one thing in which I differed from them. They were quite sure they had attained a certain "gnosis"—had, more or less successfully, solved the problem of existence; while I was quite sure I had not, and had a pretty strong conviction that the problem was insoluble. And, with Hume and Kant on my side, I could not think myself presumptuous in holding fast by that opinion. Like Dante—

"Nel mezzo del cammin di nostra vita
Mi ritrovai per una selva oscura," †

but, unlike Dante, I can not add—

"Che la diritta via era smarrita." ‡

On the contrary, I had, and have, the firmest conviction that I never left the "*verace via*"—the straight road; and that this road

* "Kritik der reinen Vernunft." Edit. Hartenstein, p. 256.

† [In the midway of this our mortal life
I found me in a gloomy wood astray.]

‡ [Gone from the path direct.]

led nowhere else but into the dark depths of a wild and tangled forest. And though I have found leopards and lions in the path; though I have made abundant acquaintance with the hungry wolf, that with "privy paw devours apace and nothing said," as another great poet says of the ravening beast; and though no friendly specter has even yet offered his guidance, I was, and am, minded to go straight on, until I either come out on the other side of the wood, or find there is no other side to it—at least, none attainable by me.

This was my situation when I had the good fortune to find a place among the members of that remarkable confraternity of antagonists, long since deceased, but of green and pious memory, the Metaphysical Society. Every variety of philosophical and theological opinion was represented there, and expressed itself with entire openness; most of my colleagues were *-ists* of one sort or another; and, however kind and friendly they might be, I, the man without a rag of a label to cover himself with, could not fail to have some of the uneasy feelings which must have beset the historical fox when, after leaving the trap in which his tail remained, he presented himself to his normally elongated companions. So I took thought, and invented what I conceived to be the appropriate title of "agnostic." It came into my head as suggestively antithetic to the "gnostic" of Church history, who professed to know so much about the very things of which I was ignorant; and I took the earliest opportunity of parading it at our society, to show that I, too, had a tail, like the other foxes. To my great satisfaction, the term took; and when the "Spectator" had stood godfather to it, any suspicion in the minds of respectable people, that a knowledge of its parentage might have awakened, was, of course, completely lulled.

That is the history of the origin of the terms "agnostic" and "agnosticism"; and it will be observed that it does not quite agree with the confident assertion of the reverend Principal of King's College, that "the adoption of the term agnostic is only an attempt to shift the issue, and that it involves a mere evasion" in relation to the Church and Christianity.*

The last objection (I rejoice, as much as my readers must do, that it is the last) which I have to take to Dr. Wace's deliverance before the Church Congress arises, I am sorry to say, on a question of morality.

"It is, and it ought to be," authoritatively declares this official representative of Christian ethics, "an unpleasant thing for a man to have to say plainly that he does not believe in Jesus Christ" (*l. c.*, p. 254).

Whether it is so, depends, I imagine, a good deal on whether

* "Report of the Church Congress," Manchester, 1888, p. 252.

the man was brought up in a Christian household or not. I do not see why it should be "unpleasant" for a Mohammedan or a Buddhist to say so. But that "it ought to be" unpleasant for any man to say anything which he sincerely, and after due deliberation, believes, is, to my mind, a proposition of the most profoundly immoral character. I verily believe that the great good which has been effected in the world by Christianity has been largely counteracted by the pestilent doctrine on which all the churches have insisted, that honest disbelief in their more or less astonishing creeds is a moral offense, indeed a sin of the deepest dye, deserving and involving the same future retribution as murder and robbery. If we could only see, in one view, the torrents of hypocrisy and cruelty, the lies, the slaughter, the violations of every obligation of humanity, which have flowed from this source along the course of the history of Christian nations, our worst imaginations of hell would pale beside the vision.

A thousand times, no! It ought *not* to be unpleasant to say that which one honestly believes or disbelieves. That it so constantly is painful to do so, is quite enough obstacle to the progress of mankind in that most valuable of all qualities, honesty of word or of deed, without erecting a sad concomitant of human weakness into something to be admired and cherished. The bravest of soldiers often, and very naturally, "feel it unpleasant" to go into action; but a court-martial which did its duty would make short work of the officer who promulgated the doctrine that his men *ought* to feel their duty unpleasant.

I am very well aware, as I suppose most thoughtful people are in these times, that the process of breaking away from old beliefs is extremely unpleasant; and I am much disposed to think that the encouragement, the consolation, and the peace afforded to earnest believers in even the worst forms of Christianity are of great practical advantage to them. What deductions must be made from this gain on the score of the harm done to the citizen by the ascetic other-worldliness of logical Christianity; to the ruler, by the hatred, malice, and all uncharitableness of sectarian bigotry; to the legislator, by the spirit of exclusiveness and domination of those that count themselves pillars of orthodoxy; to the philosopher, by the restraints on the freedom of learning and teaching which every church exercises, when it is strong enough; to the conscientious soul, by the introspective hunting after sins of the mint and cummin type, the fear of theological error, and the overpowering terror of possible damnation, which have accompanied the churches like their shadow, I need not now consider; but they are assuredly not small. If agnostics lose heavily on the one side, they gain a good deal on the other. People who talk about the comforts of belief appear to forget its discomforts;

they ignore the fact that the Christianity of the churches is something more than faith in the ideal personality of Jesus, which they create for themselves, *plus* so much as can be carried into practice, without disorganizing civil society, of the maxims of the Sermon on the Mount. Trip in morals or in doctrine (especially in doctrine), without due repentance or retractation, or fail to get properly baptized before you die, and a *plébiscite* of the Christians of Europe, if they were true to their creeds, would affirm your everlasting damnation by an immense majority.

Preachers, orthodox and heterodox, din into our ears that the world can not get on without faith of some sort. There is a sense in which that is as eminently as obviously true; there is another, in which, in my judgment, it is as eminently as obviously false, and it seems to me that the hortatory, or pulpit, mind is apt to oscillate between the false and the true meanings, without being aware of the fact.

It is quite true that the ground of every one of our actions, and the validity of all our reasonings, rest upon the great act of faith, which leads us to take the experience of the past as a safe guide in our dealings with the present and the future. From the nature of ratiocination it is obvious that the axioms on which it is based can not be demonstrated by ratiocination. It is also a trite observation that, in the business of life, we constantly take the most serious action upon evidence of an utterly insufficient character. But it is surely plain that faith is not necessarily entitled to dispense with ratiocination because ratiocination can not dispense with faith as a starting-point; and that because we are often obliged, by the pressure of events, to act on very bad evidence, it does not follow that it is proper to act on such evidence when the pressure is absent.

The writer of the epistle to the Hebrews tells us that "faith is the assurance of things hoped for, the proving of things not seen." In the authorized version "substance" stands for "assurance," and "evidence" for "the proving." The question of the exact meaning of the two words, ὑπόστασις and ἔλεγχος, affords a fine field of discussion for the scholar and the metaphysician. But I fancy we shall be not far from the mark if we take the writer to have had in his mind the profound psychological truth that men constantly feel certain about things for which they strongly hope, but have no evidence, in the legal or logical sense of the word; and he calls this feeling "faith." I may have the most absolute faith that a friend has not committed the crime of which he is accused. In the early days of English history, if my friend could have obtained a few more compurgators of like robust faith, he would have been acquitted. At the present day, if I tendered myself as a witness on that score, the judge would tell me to stand down, and the youngest barrister would smile at my simplicity. Miserable indeed is the man who has not such faith in some of his fellow-men—only less miserable than the man who allows himself to forget that such faith is not, strictly speaking, evidence; and when his faith is disappointed, as will happen now and again, turns Timon and blames the universe for his own blunders. And so, if a man can find a friend, the hypostasis of all his hopes, the mirror of his ethical ideal, in the Jesus of any, or all, of the Gospels, let him live by faith in that ideal. Who shall or can forbid him? But let him not delude himself with the notion that his faith is evidence of the objective reality of that in which he trusts. Such evidence is to be obtained only by the use of the methods of science, as applied to history and to literature, and it amounts at present to very little.

It appears that Mr. Gladstone, some time ago, asked Mr. Laing if he could draw up a short summary of the negative creed; a body of negative propositions, which have so far been adopted on the negative side as to be what the Apostles' and other accepted creeds are on the positive; and Mr. Laing at once kindly obliged Mr. Gladstone with the desired articles—eight of them.

If any one had preferred this request to me, I should have replied that, if he referred to agnostics, they have no creed; and, by the nature of the case, can not have any. Agnosticism, in fact, is not a creed, but a method, the essence of which lies in the rigorous application of a single principle. That principle is of great antiquity; it is as old as Socrates; as old as the writer who said, "Try all things, hold fast by that which is good"; it is the foundation of the Reformation, which simply illustrated the axiom that every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science. Positively the principle may be expressed: In matters of the intellect, follow your reason as far as it will take you, without regard to any other consideration. And negatively: In matters of the intellect, do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which if a man keep whole and undefiled, he shall not be ashamed to look the universe in the face, whatever the future may have in store for him.

The results of the working out of the agnostic principle will vary according to individual knowledge and capacity, and according to the general condition of science. That which is unproved to-day may be proved, by the help of new discoveries, to-morrow. The only negative fixed points will be those negations which flow from the demonstrable limitation of our faculties. And the only obligation accepted is to have the mind always open to conviction. Agnostics who never fail in carrying out their principles are, I am afraid, as rare as other people of whom the same consistency can be truthfully predicated. But, if you were to meet with such a phœnix and to tell him that you had discovered that two and two make five, he would patiently ask you to state your reasons for that conviction, and express his readiness to agree with you if he found them satisfactory. The apostolic injunction to "suffer fools gladly," should be the rule of life of a true agnostic. I am deeply conscious how far I myself fall short of this ideal, but it is my personal conception of what agnostics ought to be.

However, as I began by stating, I speak only for myself; and I do not dream of anathematizing and excommunicating Mr. Laing. But, when I consider his creed and compare it with the Athanasian, I think I have, on the whole, a clearer conception of the meaning of the latter. "Polarity," in Article viii, for example, is a word about which I heard a good deal in my youth, when "Naturphilosophie" was in fashion, and greatly did I suffer from it. For many years past, whenever I have met with "polarity" anywhere but in a discussion of some purely physical topic, such as magnetism, I have shut the book. Mr. Laing must excuse me if the force of habit was too much for me when I read his eighth article.

And now, what is to be said to Mr. Harrison's remarkable deliverance "On the future of agnosticism"?* I would that it were not my business to say anything, for I am afraid that I can say nothing which shall manifest my great personal respect for this able writer, and for the zeal and energy with which he ever and anon galvanizes the weakly frame of positivism until it looks more than ever like John Bunyan's Pope and Pagan rolled into one. There is a story often repeated, and I am afraid none the less mythical on that account, of a valiant and loud-voiced corporal, in command of two full privates, who, falling in with a regiment of the enemy in the dark, orders it to surrender under pain of instant annihilation by his force; and the enemy surrenders accordingly. I am always reminded of this tale when I read the positivist commands to the forces of Christianity and of Science; only the enemy show no more signs of intending to obey now than they have done any time these forty years.

The allocution under consideration has the papal flavor which is wont to hang about the utterances of the pontiffs of the Church of Comte. Mr. Harrison speaks with authority, and not as one of the common scribes of the period. He knows not only what

* "Fortnightly Review," January, 1889.

agnosticism is and how it has come about, but what will become of it. The agnostic is to content himself with being the precursor of the positivist. In his place, as a sort of navvy leveling the ground and cleansing it of such poor stuff as Christianity, he is a useful creature who deserves patting on the back, on condition that he does not venture beyond his last. But let not these scientific Sanballats presume that they are good enough to take part in the building of the Temple—they are mere Samaritans, doomed to die out in proportion as the Religion of Humanity is accepted by mankind. Well, if that is their fate, they have time to be cheerful. But let us hear Mr. Harrison's pronouncement of their doom:

"Agnosticism is a stage in the evolution of religion, an entirely negative stage, the point reached by physicists, a purely mental conclusion, with no relation to things social at all" (p. 154). I am quite dazed by this declaration. Are there, then, any "conclusions" that are not "purely mental"? Is there "no relation to things social" in "mental conclusions" which affect men's whole conception of life? Was that prince of agnostics, David Hume, particularly imbued with physical science? Supposing physical science to be non-existent, would not the agnostic principle, applied by the philologist and the historian, lead to exactly the same results? Is the modern more or less complete suspension of judgment as to the facts of the history of regal Rome, or the real origin of the Homeric poems, anything but agnosticism in history and in literature? And if so, how can agnosticism be the "mere negation of the physicist"?

"Agnosticism is a stage in the evolution of religion." No two people agree as to what is meant by the term "religion"; but if it means, as I think it ought to mean, simply the reverence and love for the ethical ideal, and the desire to realize that ideal in life, which every man ought to feel—then I say agnosticism has no more to do with it than it has to do with music or painting. If, on the other hand, Mr. Harrison, like most people, means by "religion" theology, then, in my judgment, agnosticism can be said to be a stage in its evolution, only as death may be said to be the final stage in the evolution of life.

When agnostic logic is simply one of the canons of thought, agnosticism, as a distinctive faith, will have spontaneously disappeared (p. 155).

I can but marvel that such sentences as this, and those already quoted, should have proceeded from Mr. Harrison's pen. Does he really mean to suggest that agnostics have a logic peculiar to themselves? Will he kindly help me out of my bewilderment when I try to think of "logic" being anything else than the canon (which, I believe, means rule) of thought? As to agnosticism being a distinctive faith, I have already shown that it can not possibly be anything of the kind; unless perfect faith in logic is distinctive of agnostics, which, after all, it may be.

Agnosticism as a religious philosophy *per se* rests on an almost total ignoring of history and social evolution (p. 152).

But neither *per se* nor *per alind* has agnosticism (if I know anything about it) the least pretension to be a religious philosophy; so far from resting on ignorance of history, and that social evolution of which history is the account, it is and has been the inevitable result of the strict adherence to scientific methods by historical investigators. Our forefathers were quite confident about the existence of Romulus and Remus, of King Arthur, and of Hengst and Horsa. Most of us have become agnostics in regard to the reality of these worthies. It is a matter of notoriety, of which Mr. Harrison, who accuses us all so freely of ignoring history, should not be ignorant, that the critical process which has shattered the foundations of orthodox Christian doctrine owes its origin, not to the devotees of physical science, but, before all, to Richard Simon, the learned French Oratorian, just two hundred years ago. I can not find evidence that either Simon, or any one of the great scholars and critics of the eighteenth and nineteenth centuries who have continued Simon's work, had any particular acquaintance with physical science. I have already pointed out that Hume was independent of it. And certainly one of the most potent influences in the same direction, upon history in the present century, that of Grote, did not come from the physical side. Physical science, in fact, has had nothing directly to do with the criticism of the Gospels; it is wholly incompetent to furnish demonstrative evidence that any statement made in these histories is untrue. Indeed, modern physiology can find parallels in nature for events of apparently the most eminently supernatural kind recounted in some of those histories.

It is a comfort to hear, upon Mr. Harrison's authority, that the laws of physical nature show no signs of becoming "less definite, less consistent, or less popular as time goes on" (p. 154). How a law of nature is to become indefinite, or "inconsistent," passes my poor powers of imagination. But with universal suffrage and the coach-dog theory of premiership in full view; the theory, I mean, that the whole duty of a political chief is to look sharp for the way the social coach is driving, and then run in front and bark loud—as if being the leading noise-maker and guiding were the same things—it is truly satisfactory to me to know that the laws of nature are increasing in popularity. Looking at recent developments of the policy which is said to express the great heart of the people, I have had my doubts of the fact; and my love for my fellow-countrymen has led me to reflect with dread on what will happen to them, if any of the laws of nature ever become so unpopular in their eyes as to be voted down by the transcendent authority of universal suffrage. If the legion of demons, before they set out on their journey in the swine, had had time to hold a meeting and to resolve unanimously, "That the law of gravitation is oppressive and ought to be repealed," I am afraid it would have made no sort of difference to the result, when their two thousand unwilling porters were once launched down the steep slopes of the fatal shore of Gennesaret.

The question of the place of religion as an element of human nature, as a force of human society, its origin, analysis, and functions, has never been considered at all from an agnostic point of view (p. 152).

I doubt not that Mr. Harrison knows vastly more about history than I do; in fact, he tells the public that some of my friends and I have had no opportunity of occupying ourselves with that subject. I do not like to contradict any statement which Mr. Harrison makes on his own authority; only, if I may be true to my agnostic principles, I humbly ask how he has obtained assurance on this head. I do not profess to know anything about the range of Mr. Harrison's studies; but as he has thought it fitting to start the subject, I may venture to point out that, on the evidence adduced, it might be equally permissible to draw the conclusion that Mr. Harrison's absorbing labors as the *pontifex maximus* of the positivist religion have not allowed him to acquire that acquaintance with the methods and results of physical science, or with the history of philosophy, or of philological and historical criticism, which is essential to any one who desires to obtain a right understanding of agnosticism. Incompetence in philosophy, and in all branches of science except mathematics, is the well-known mental characteristic of the founder of Positivism. Faithfulness in disciples is an admirable quality in itself; the pity is that it not unfrequently leads to the imitation of the weaknesses as well as of the strength of the master. It is only such over-faithfulness which can account for a "strong mind really saturated with the historical sense" (p. 153) exhibiting the extraordinary forgetfulness of the historical fact of the existence of David Hume implied by the assertion that

it would be difficult to name a single known agnostic who has given to history anything like the amount of thought and study which he brings to a knowledge of the physical world (p. 153).

Whoso calls to mind, what I may venture to term, the bright side of Christianity; that ideal of manhood, with its strength and its patience; its justice and its pity for human frailty; its helpfulness, to the extremity of self-sacrifice; its ethical purity and nobility; which apostles have pictured, in which armies of martyrs have placed their unshakable faith, and whence obscure men and women, like Catherine of Sienna and John Knox, have derived the courage to rebuke popes and kings, is not likely to underrate the importance of the Christian faith as a factor in human history, or to doubt that if that faith should prove to be incompatible with our knowledge, or necessary want of knowledge, some other hypostasis of men's hopes, genuine enough and worthy enough to replace it, will arise. But that the incongruous mixture of bad science with eviscerated papistry, out of which Comte manufactured the positivist religion, will be the heir of the Christian ages, I have too much respect for the humanity of the future to believe. Charles II told his brother, "They will not kill me, James, to make you king." And if critical science is remorselessly destroying the historical foundations of the noblest ideal of humanity which mankind have yet worshiped, it is little likely to permit the pitiful reality to climb into the vacant shrine.

That a man should determine to devote himself to the service of humanity—including intellectual and moral self-culture under that name; that this should be, in the proper sense of the word, his religion—is not only an intelligible, but, I think, a laudable resolution. And I am greatly disposed to believe that it is the only religion which will prove itself to be unassailably acceptable so long as the human race endures. But when the positivist asks me to worship "Humanity"—that is to say, to adore the generalized conception of men as they ever have been and probably ever will be—I must reply that I could just as soon bow down and worship the generalized conception of a "wilderness of apes." Surely we are not going back to the days of paganism, when individual men were deified, and the hard good sense of a dying Vespasian could prompt the bitter jest, "*Ut puto Deus fio.*" No divinity doth hedge a modern man, be he even a sovereign ruler. Nor is there any one, except a municipal magistrate, who is officially declared worshipful. But if there is no spark of worship-worthy divinity in the individual twigs of humanity, whence comes that godlike splendor which the Moses of positivism fondly imagines to pervade the whole bush?

I know no study which is so unutterably saddening as that of the evolution of humanity, as it is set forth in the annals of history. Out of the darkness of prehistoric ages man emerges with the marks of his lowly origin strong upon him. He is a brute, only more intelligent than the other brutes; a blind prey to impulses, which as often as not lead him to destruction; a victim to endless illusions, which make his mental existence a terror and a burden, and fill his physical life with barren toil and battle. He attains a certain degree of physical comfort, and develops a more or less workable theory of life, in such favorable situations as the plains of Mesopotamia or of Egypt, and then, for thousands and thousands of years, struggles with varying fortunes, attended by infinite wickedness, bloodshed, and misery, to maintain himself at this point against the greed and the ambition of his fellow-men. He makes a point of killing and otherwise persecuting all those who first try to get him to move on; and when he has moved on a step, foolishly confers *post-mortem* deification on his victims. He exactly repeats the process with all who want to move a step yet farther. And the best men of the best epochs are simply those who make the fewest blunders and commit the fewest sins.

That one should rejoice in the good man; forgive the bad man; and pity and help all men to the best of one's ability, is surely indisputable. It is the glory of Judaism and of Christianity to have proclaimed this truth, through all their aberrations. But the worship of a God who needs forgiveness and help, and deserves pity every hour of his existence, is no better than that of any other voluntarily selected fetich. The Emperor Julian's project was hopeful, in comparison with the prospects of the new anthropolatry.

When the historian of religion in the twentieth century is writing about the nineteenth, I foresee he will say something of this kind:

The most curious and instructive events in the religious history of the preceding century are the rise and progress of two new sects, called Mormons and Positivists. To the student who has carefully considered these remarkable phenomena nothing in the records of religious self-delusion can appear improbable.

The Mormons arose in the midst of the great Republic, which, though comparatively insignificant at that time, in territory as in the number of its citizens, was (as we know from the fragments of the speeches of its orators which have come down to us) no less remarkable for the native intelligence of its population, than for the wide extent of their information, owing to the activity of their publishers in diffusing all that they could invent, beg, borrow, or steal. Nor were they less noted for their perfect freedom from all restraints in thought or speech or deed; except, to be sure, the beneficent and wise influence of the majority exerted, in case of need, through an institution known as "tarring and feathering," the exact nature of which is now disputed.

There is a complete consensus of testimony that the founder of Mormonism, one Joseph Smith, was a low-minded, ignorant scamp, and that he stole the "Scriptures" which he propounded; not being clever enough to forge even such contemptible stuff as they contain. Nevertheless he must have been a man of some force of character, for a considerable number of disciples soon gathered about him. In spite of repeated outbursts of popular hatred and violence—during one of which persecutions, Smith was brutally murdered—the Mormon body steadily increased, and became a flourishing community. But the Mormon practices being objectionable to the majority, they were, more than once, without any pretense of law, but by force of riot, arson, and murder, driven away from the land they had occupied. Harried by these persecutions, the Mormon body eventually committed itself to the tender mercies of a desert as barren as that of Sinai; and, after terrible sufferings and privations, reached the oasis of Utah. Here it grew and flourished, sending out missionaries to, and receiving converts from, all parts of Europe, sometimes to the number of 10,000 in a year; until in 1880, the rich and flourishing community numbered 110,000 souls in Utah alone, while there were probably 30,000 or 40,000 scattered abroad elsewhere. In the whole history of religions there is no more remarkable example of the power of faith; and, in this case, the founder of that faith was indubitably a most despicable creature. It is interesting to observe that the course taken by the great Republic and its citizens runs exactly parallel with that taken by the Roman Empire and its citizens toward the early Christians, except that the Romans had a certain legal excuse for their acts of violence, inasmuch as the Christian "sodalitia" were not licensed, and consequently were, *ipso facto*, illegal assemblages. Until, in the latter part of the nineteenth century, the United States Legislature decreed the illegality of polygamy, the Mormons were wholly within the law.

Nothing can present a greater contrast to all this than the history of the Positivists. This sect arose much about the same time as that of the Mormons, in the upper and most instructed stratum of the quick-witted, skeptical population of Paris. The founder, Auguste Comte, was a teacher of mathematics, but of no eminence in that department of knowledge, and with nothing but an amateur's acquaintance with physical, chemical, and biological science. His works are repulsive on account of the dull diffuseness of their style, and a certain air, as of a superior person, which characterizes them; but, nevertheless, they contain good things here and there. It would take too much space to reproduce in detail a system which proposes to regulate all human life by the promulgation of a gentile Leviticus. Suffice it to say that M. Comte may be described as a syncretic, who, like the gnostics of early Church history, attempted to combine the substance of imperfectly comprehended contemporary science with the form of Roman Christianity. It may be that this is the reason why his disciples were so very angry with some obscure people called Agnostics, whose views, if we may judge by the accounts left in the works of a great positivist controversial writer, were very absurd.

To put the matter briefly, M. Comte, finding Christianity and Science at daggers drawn, seems to have said to Science: "You find Christianity rotten at the core, do you? Well, I will scoop out the inside of it." And to Romanism: "You find Science mere dry light—cold and bare. Well, I will put your shell over it, and so, as schoolboys make a specter out of a turnip and a tallow candle, behold the new religion of Humanity complete!"

Unfortunately, neither the Romanists nor the people who were something more than amateurs in science could be got to worship M. Comte's new idol properly. In the native country of Positivism, one distinguished man of letters and one of science, for a time, helped to make up a roomful of the faithful, but their love soon grew cold. In England, on the other hand, there appears to be little doubt that, in the ninth decade of the century, the multitude of disciples reached the grand total of several score. They had the advantage of the advocacy of one or two most eloquent and learned apostles, and, at any rate, the sympathy of several persons of light and leading—and, if they were not seen, they were heard all over the world. On the other hand, as a sect, they labored under the prodigious disadvantage of being refined, estimable people, living in the midst of the worn-out civilization of the Old World; where any one who had tried to persecute them, as the Mormons were persecuted, would have been instantly hanged. But the majority never dreamed of persecuting them; on the contrary, they were rather given to scold, and otherwise try the patience of, the majority.

The history of these sects in the closing years of the century is highly instructive. Mormonism . . .

But I find I have suddenly slipped off Mr. Harrison's tripod, which I had borrowed for the occasion. The fact is, I am not equal to the prophetical business, and ought not to have undertaken it.—*Nineteenth Century.*

Something, it appears, is to be said in favor of the theory that the earth has received and is receiving supplies of carbon from meteors and space. A meteor that was found at Youndegin, Western Australia, in 1854, contained carbon of a form resembling graphite, but harder, and occurring in cubic crystals, of which about a hundred were separated. Observations of geological strata indicate an increase of carbon in the crust of the earth since the earliest times, for the rocks of the older formations contain less of it than those of the carboniferous and succeeding ones. Dr. Sterry Hunt has attributed the additional supplies to carbonic-acid gas diffused in space, and holds that the supposition that our atmosphere ever contained the whole amount at once would involve the presence of more enormous quantities of it than we can reasonably admit.

DOMESTICATION OF THE BUFFALO.

By JOHN W. DAFOE.

ONE of the most striking results due to the building of trans-continental railroads is the approach to extinction of the buffalo. Its vast range once extended from Great Slave Lake to the northeastern provinces of Mexico, and in British territory from the Rockies to wooded highlands six hundred miles west of Hudson's Bay. In the United States, remains of buffaloes have been found west of the Rockies in Oregon, in the Great Salt Lake basin, and westward as far as the Sierra Nevada. Of the species *bison*, two well-defined varieties are known, the prairie and the wood or mountain buffalo. The latter, compared with the other, is larger, coarser-haired, straighter-horned, and excessively shy. This shyness, together with the protection its habitat of forest affords it, have preserved its numbers in larger proportion than those of its congener of the prairies. Although the buffalo is savage of aspect and strong of limb, yet it is much less formidable to a hunter than the so-called tame cattle of the Texan plains. It is an expert and fearless climber, and only a very swift horse can overtake it, yet its stupidity and lack of courage have had not a little to do with the sweeping destruction which has overtaken it. As long ago as 1825, Prof. Joel A. Allen tells us, in his valuable monograph, "The History of the American Bison," it had been exterminated throughout the whole region east of the Mississippi, except for a limited area lying around the sources of that river. This extermination was utterly wanton; buffalo-hunting was chiefly mere sport, and often the only portion of the carcass removed was the tongue, much esteemed as a tidbit. In gainful hunting, it was rarely the buffalo's meat that was sought; its robe was the object of its relentless pursuit. This pursuit was immensely facilitated by the Pacific Railroads, which at the same time opened up new markets both for robes and meat. Colonel H. I. Dodge, author of "The Plains of the Great West," estimates that, in the three years ending with 1874, no fewer than 5,500,000 buffaloes were slaughtered. Mr. Miller Christy, who carefully took a census of the species last year, finds their total number to be but 1,100 or thereabout. So wantonly have the buffaloes been slain that their very bones have become an article of commerce. Regina, the seat of the territorial government of the Canadian Northwest, is built on Pile-of-Bones Creek, so called from the vast accumulation which encumbered its banks. Throughout the whole Western prairie region the earth is pitted with buffalo-wallows, often deep enough to long survive cultivation. These wallows are due to the instinct whereby the huge brute, with a quickness which would not be expected of it, can roll itself in loam until it has donned a garment impervious to flies, and which in falling away carries off loose hair. When only dry, dusty soil is available, the buffalo will roll in that, greatly to the prejudice of its insect parasites. Wallows thus formed, numerous enough to testify to the comparatively recent existence of vast herds, can be most easily seen about the time of sunrise or sunset, when the almost horizontal solar beams throw them into shadow. In years gone by it was not uncommon to find in the hot springs of the Yellowstone Park, and of Banff, in the Canadian National Park, the remains of a buffalo strayed from a herd to find death in a scalding basin. The reckless extirpation of the buffalo has been fraught with very serious consequences to Indian tribes north and south of the international boundary. One of their hardships, which has been the frequent source of complaint and rebellion, has been the deprivation of buffalo-meat which in large areas was the Indian's principal food. Scarcely less serious has been the like deprivation entailed upon pioneer settlers, whose sites have in many cases been indicated to them by the buffalo-trails. In their migrations between north and south, and in their search for herbage least covered with snow, the buffalo has ever marked out the best and most feasible path.

While, as in other departments of her great natural wealth, America has been prodigal and spendthrift, there have been several noteworthy attempts not only to stay the threatened extermination of the buffalo, but to multiply its numbers and improve the race by crossing it with domestic cattle. It is curious how far back experiments in this direction date. Peter Kalm, in his "Travels in North America," says that buffaloes were domesticated in Quebec in 1750, and that in Carolina they had been crossed with domestic cattle. So docile indeed was a buffalo bull mentioned in Schoolcraft's "History of the Indians of the United States," that he had been yoked to the plow. Robert Wickliffe, of Lexington, Ky., in 1843, wrote Audubon and Bachman that he had secured quarter, half, and three-quarter crosses between the buffalo and domestic cattle. The progeny were tame, worked in yoke, exceeded the ox in strength, and retained the wallowing habit. All the half-bred heifers were fertile, but the half-bred bulls were not. Colonel George C. Thompson, of Shawnee Springs, Ky., concurrently with Mr. Wickliffe's experiment, domesticated a buffalo bull and three buffalo cows; they were thoroughly docile, hardy, and long-lived. Mr. I. W. Cunningham, of Howard County, Neb., in 1878, recorded that both domestication and crossing had been successful in the county mentioned—just as in Mr. Wickliffe's case. However, with the horse as a competitor as a draught-animal, and the ox and cow as their rivals in the production of beef and milk, buffaloes have not until recent years sufficiently risen in value to warrant their domestication and breeding being taken up systematically and on a large scale. It is their rapid approach to extinction that has made the man of business succeed to the curious experimenter of a decade or a century ago,

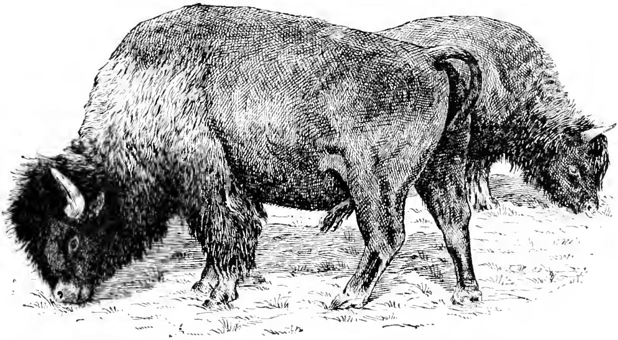


FIG. 1.—FULL-BLOOD BUFFALOES DOMESTICATED.

and recognize how much of value there is in a strain which, if opportunity be not promptly seized, will soon be no more than a remembrance. Regarding, then, the buffalo as an animal well worthy conserving, what are his good and bad points? First of all, he is hardy, not liable to disease, and on the plains of the American and Canadian Northwest he can forage in deep snow and live in the open air all winter long. His meat brings nearly as good a price as beef. His robe is worth $25 to $40; and his head taxidermized, thanks to the decorative tastes of sportsmen, fetches as much as the robe, or even more. So much for the credit side of the account; now for the debit. The buffalo is a strong brute, and of a temper at times so fierce that his domestication is a task not seldom accompanied by decided hazard. Ordinary fences are as gossamer to a buffalo bull, especially during the irritable years when he is past his prime and finds himself less attractive than of yore. Still, the example of well-behaved domestic cattle, with which buffaloes readily amalgamate, is very effective. It is not, however, in mere domestication, but in cross-breeding that the buffalo's value consists. In pairing a buffalo bull and domestic cow the young are brought forth without any unusual percentage of loss being sustained. The offspring combines good points of sire and dam. It has nearly all its sire's hardiness and strength, and so much of its dam's tractability as to be well suited for draught purposes. When killed, the net weight of its carcass exceeds that of a buffalo's, while the meat is better. Such a carcass has been known to weigh as much as 1,100 pounds net. Its robe is much more valuable than the buffalo's; for its fur, instead of being chiefly bunched at the

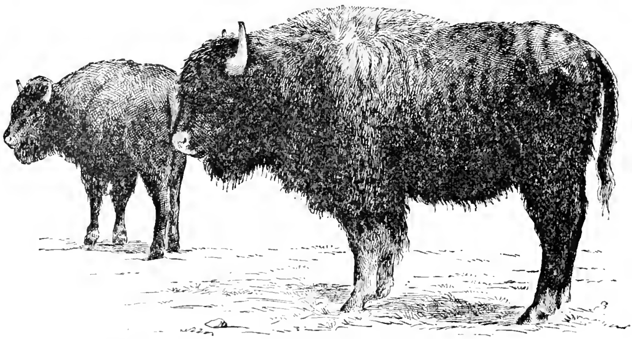


FIG. 2.—THREE-QUARTER-BLOOD BUFFALOES. Cross between Buffalo Bull and Half-blood Buffalo Cow.

mane, is evenly distributed over the hide, and is much finer in quality—its present value being from $50 to $75. A buffalo crossed with a half-bred cow produces an animal quite as hardy as its sire, but not quite so large. Experiments of much interest are in progress with various strains of domestic cattle, the outcome promising to be perhaps only less important than the original domestication, and subsequent molding, of horses and cattle from their primitive wild forms.

Chief among the ranches where the domestication of the buffalo is taking place and its crosses are being bred is that of Mr. C. J. Jones, at Garden City, Kan. The nucleus of his herd, seven calves and fifteen adult buffaloes, were run down by him on the Texan plains, two to three hundred miles from Garden City. He has crossed Texan cows with buffalo bulls, and obtained excellent results. In November last he acquired a herd of eighty-three animals from Mr. Samuel L. Bedson, of Stony Mountain, sixteen miles from Winnipeg, the capital of Manitoba. The crosses in this herd were from Galloway or polled Angus cattle; they are much superior to those from Texan strains, and are presented in the accompanying illustrations. Mr. Bedson's herd dated from 1877, when he first corraled a buffalo bull and four heifers. These five animals were part of the small remnant grazing in the vast region between the Saskatchewan River and the international boundary, the region now traversed by the Canadian Pacific Railway. In that immense plain the slaughter of buffaloes, due to the traffic of the Hudson's Bay Company, had been for two centuries much more active than that on American soil. In eleven years Mr. Bedson's herd increased from five to ninety-seven, fourteen of the number having been disposed of before the sale to Mr. Jones. Of the eighty-three which he bought, there are eight adult crosses, or grades as they are called, and seventeen calves of 1888, pure and grade. It is Mr. Jones's intention thor-

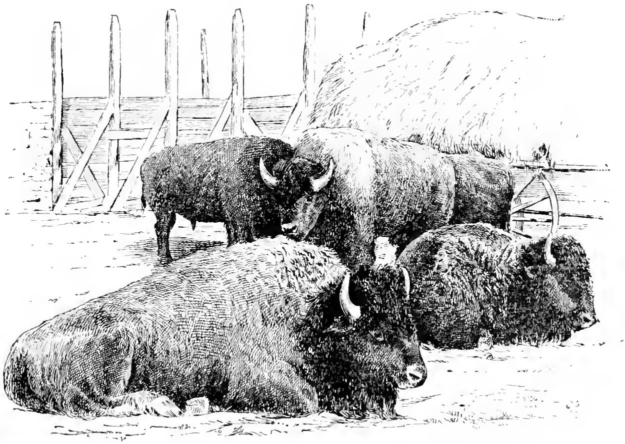


FIG. 3.—HALF-BLOOD BUFFALOES. Cross between Buffalo Bull and Domestic Cow.

oughly to test various strains with a view to ascertain which are best adapted for grazing herds on the plains of the Northwest. In producing a robe he has already attained what he calls a "seal-skin buffalo," from crossing with black cattle.

At Silver Heights, five miles from Winnipeg, Sir Donald Smith has a small herd of buffalo-crosses presenting unique points in beauty and docility. Elsewhere in Manitoba, in Alberta Territory, and in Minnesota, it is proposed to parallel Mr. Jones's enterprise of Garden City.

IT has been suggested as an additional advantage of technical education that it will afford room for the cultivation of what may be called man's instinctive intelligence, for which hardly any provision is made in the present systems. "While the rational faculties and purely physical capabilities are elaborately cared for, practically nothing is done, save in the most casual and hap-hazard way, for improving the faculties which lie upon the border-land of instinct and reason," for the development of such powers, for example, as the exquisite adjustment and co-ordination that give the cricketer's skill in catching a passing ball, or the violinist's in eliciting a succession of enrapturing harmonies from his instrument. Genius can not be manufactured or conferred, but the average of the instinctive intelligence and facility might be greatly raised by well-directed training.

ZOÖLOGICAL GARDENS: THEIR USES AND MANAGEMENT.

By R. W. SHUFELDT, M. D., C. M. Z. S.

RARELY has it been in the history of the world that a city which has become famous as a scientific and literary center has not, sooner or later, inaugurated, developed, and maintained its collection of living wild animals, its zoölogical gardens. Indeed, in modern times, as of old, in large civilized communities, it has come to be where such establishments are in existence, and kept up to a high state of perfection and growth, that they are the very badge denoting the presence of marked intellectual activity along the lines we have indicated. With respect to the instances of this in history, they are too well known to the general reader to require enumeration here, while we are all familiar with the names of those cities of our own day wherein such institutions are now flourishing.

In modern times, again, the enormous impulse which the biological sciences have received, the far keener appreciation on the part of the reading public in such matters; and the pressing necessity for such material as zoölogical gardens can alone supply the morphologist, artist, and animal historian, are, we must believe, the principal forces that eventually give birth to these collections.

The uses of a zoölogical garden to a civilized country are manifold, and not easily to be overestimated. These uses are considerably enhanced if it is established within easy access of large biological museums and libraries. Sometimes it so happens, however, that in a large city where zoölogical gardens, museums, and libraries exist, the former may be situated several miles from the last two mentioned, and this is the misfortune to which we more particularly refer, and, if it can be avoided, should be by all means.

If properly conducted, a zoölogical garden sees its chief use in being a powerful auxiliary to those more general schemes undertaken on the part of the state for the benefit of the community at large, in which educational ends are to be met. And in the management of such a garden, everything connected with it should be continually bent in that direction; the managers should ever keep clearly before their minds this fact, that the principal object they have in view is an educational one—that they have under their control an engine capable of diffusing annually among the people an incalculable store of highly useful knowledge. The moment that such an institution sinks to the level of a purposelessly arranged and heterogeneously selected collection of animals, the throngs that stream through the garden grounds will resort there as curiosity-seekers, and will lose sight of the idea that they are in a place and enjoying an atmosphere of culture, refinement, and education. History goes to show that the superb zoölogical gardens now maintained in London were first opened in 1828, since which time, down to 1887, twenty-four million five hundred and seventy-two thousand four hundred and five visitors were entered upon the register-books of the management. An instant's reflection will be sufficient to convince any friend of education of the benefits that humanity has derived hence, and of the refining influences which have through this center alone been brought into play.

Extensive zoölogical gardens, in addition, open to the masses a long chapter on the life-histories of the animals of their own country, as well as those of foreign lands. Then by the proper methods it becomes easy to bring the visitor face to face with other questions intimately associated with the animals themselves: I refer to their geographical ranges; the physical aspect of the countries they inhabit; and, finally, through the library and lecture system, something about their natural history and structure.

People are by such means enabled to supplement their readings and studies by having the very objects brought before them. At a glance, the striking differences between the Asiatic and African elephants are appreciated through the eye. One soon becomes familiar with the various forms of our American deer, and has a better realizing sense of the fact that the elk resort to the mountain fastnesses as their normal haunts, while our antelope rarely quit the plains. From school-days up, the American youth, by such means, gains a knowledge of the forms of the magnificent representatives of the various faunæ of his land, in comparison with which the illustrations in the text-book, although not to be altogether despised, are inadequate.

Here the sculptor, artist, and engraver can, at their leisure, study the noblest of animal forms under the most advantageous of circumstances. Leopards and pumas may be caught in the very act of a high-noon *siesta*, or perchance in some short and fiery quarrel, showing all the lineaments of anger characteristic of their race when aroused. Ornithologists may catch for their folios the transitory tints of the glowing plumages of trogons and toucans as they disport themselves in their large, airy cages, in a manner to be achieved under no other conditions. Then, by the aid of camera, brush, and pencil, tints and forms are brought to the eye and hand of the sculptor and engraver, which in time take on material shape in bronze and stone, and the ideas pass into art and design, and thus culture is the gainer in the end.

It is here, again, that a thousand facts each year are brought directly under the observation of the naturalist and specialist in every department of biology—nidification in all its details among birds; all the data in connection with the breeding habits of mammals; and a volume of unwritten lore having reference to the life-histories of our native reptiles and their kin.

Nor is this all, for it is at the zoölogical garden that the morphologist, surrounded as he there is by all the conveniences that civilization can bring, finds that priceless opportunity to carry on his researches upon the structure of animals, in ways that he could not do under any other circumstances; for material is here brought before him that, as a rule, not only admits of the investigation of individual forms, but from its abundance enables him, like Garrod in London, to draw conclusions from the anatomy presented by whole natural groups, and thus science is an enormous gainer.

It will be seen, then, from what has gone before, that not only are great pleasure and enjoyment of a highly elevating character brought to thousands of people annually, who have the opportunity of frequenting a large zoölogical garden, but those ultimate ends of all human activities—education, culture, art, and science—are immensely benefited thereby; and this implies a powerful and constant operation of a good influence for all mankind.

When a city distinguished as being a scientific center, or mayhap the national capital—and this itself may be such a city—determines upon establishing a zoölogical garden within its precincts, a great deal depends upon the site which is chosen for the purpose.

If possible, the form of the grounds should be a regular figure, an oblong being one of the best, with a long side toward the direction whence come the prevailing winds, as this assists in securing good ventilation; and the area should include at least two hundred to two hundred and fifty acres. The site should be within some convenient distance of the city museums and libraries; surely not separated from these by more than three miles at the most. Another matter of great importance is the character of the country, which should be as diversified as possible; and the inclosure should contain a few sizable ponds or a good, strong stream of water, in which event the former can be easily constructed artificially. Old trees in groups; some low, level marshland; and some hills and rocky portions, are all points of extreme natural advantage. These latter features, if marked, usually insure, too, another benefit, for then hilly or broken country is likely to be found immediately beyond the limits of the garden, which, though conducive to the building of handsome suburban residences, is not likely to fill up entirely with houses as the city increases in size; and thus excellent ventilation is secured for all time.

There are several highly important elements which should be paramount in the administration of the affairs of such an institution in order to insure its highest success and most healthy growth and usefulness. Chief among these is the matter of choice of the persons selected to constitute the staff of such a zoölogical garden as we have in mind. Next are the methods of confining and exhibiting the collection of animals of the place; the regulations controlling its sanitation and keeping; and provision of those steps which lead to the public and special workers deriving the greatest amount of benefit from it, in a purely educational point of view, incorporating here the subservience of Science in her diverse ends and means.

In the spring of this year (1888), the Zoölogical Society of London, in addition to its regular staff of officers, employed the following persons: one superintendent, one assistant superintendent, one head keeper, six keepers (first class), ten keepers (second class), eight keepers (third class), three money-takers, one storekeeper, one cook, one office-clerk, one prosector's assistant, one head gardener, nineteen helpers in the menagerie, ten garden laborers, seven artisans, two painters, six laborers, one butcher, two firemen, two night watchmen, and one time-keeper—making a whole force of about eighty-five people, the duties of whom are sufficiently suggested by their designations. It is hardly necessary to say that the gentlemen composing the staff of officers should be selected not only for their executive ability in the departments they severally fill, but likewise for their distinction in some branch of zoölogical science, and more especially vertebrate zoology. Of that part of the staff which has just been enumerated above, especial regard should be paid to the selection of the keepers, who should be men fond of animals and their care, gentle and patient, and otherwise particularly fitted for their employment.

A great deal depends upon the various methods adopted of exhibiting the different mammals, birds, and reptiles in the collection, not only so far as the comfort of these is concerned, but the amount of instruction and benefit we derive from the several plans employed. For instance, it would hardly be considered advisable to keep specimens of the Rocky Mountain goat (*Mazama*) within an inclosure wherein the ground was a dead level, and specimens of the prong-horn antelope (*Antilocapra*) in another inclosure wherein a rocky hillock of some considerable dimensions might exist: for, in the first instance, the animal would not only be unhappy in his quarters, but would be made incapable of exhibiting a number of his natural traits; while a mass of rocks in the antelope inclosure would be a waste of material, and take up room that the animals might otherwise enjoy.

Prof. Flower, the President of the London Zoölogical Society, in his address on the 16th of June, 1887, to the general meeting, made some excellent remarks upon this point when he said that "the old idea of keeping animals in small, cramped cages and dens, inherited from the Tower and traveling wild-beast shows, still lingers in many places. We have a responsibility to our captive animals, brought from their native wilds to minister to our pleasure and instruction, beyond that of merely supplying them with food and shelter. The more their comfort can be studied, and roomier their place of captivity, the more they are surrounded by conditions reproducing those of their native haunts, the happier they will be, and the more enjoyment and instruction we shall obtain when looking at them." Then continuing, and referring to the London gardens, he said: "Many of our newest improvements are markedly in this direction. I may especially mention the new inclosure for wild sheep near the lion-house in the South Garden, with its picturesque rock-work and fall of water, and the large aviary for herons and similar birds just completed on what used to be called the Water-Fowls' Lawn."

The writer is convinced of the truth of these words, from his own studies of zoölogical gardens in this country and abroad.

Again, to show the bad effects of the overcrowding of animals, Prof. Flower further observed, still confining himself to the London gardens: "The primary habitation of the lions and other large feline animals was the building on the north side of the tunnel, which many of us may remember as a reptile-house, and which has been lately restored as a dwelling-place for the smaller carnivora. The council reports of the period frequently speak of the bad accommodation it afforded to the inmates, the consequent injury to their health, and the disagreeable effects on visitors from the closeness of the atmosphere. In September, 1843, the terrace, with its double row of cages beneath, was completed; and the report of the following spring, speaking of this as 'one of the most important works ever undertaken at the gardens,' congratulates the society upon the fact that the anticipations of the increased health of this interesting portion of the collection, resulting from a free exposure to the external air and total absence of artificial heat, had been fully realized. The effects of more air and greater exercise were indeed said to have become visible almost immediately. Animals which were emaciated and sickly before their removal became plump and sleek in a fortnight after, and the appetites of all were so materially increased that they began to kill and eat each other. This, however, led to an immediate increase in their allowance of food, since which time, it is stated, no further accidents of the kind have occurred."

Very often, when birds are kept in cramped quarters, they can not be induced to show off any of their peculiar habits, much less take to breeding. This was well seen in the case of the herons a year or so ago in the London gardens; for, as soon as these birds were transferred from their limited confines to the large new aviary constructed for them, and inclosing natural waters, trees, and shrubs, they resumed at once some of their more natural habits, while the ibises built in the trees and reared their young. Some mammals and birds bear confinement in narrow habitations better than others; and one can easily imagine that a sloth would tolerate a curtailment of his liberties far better than many species of monkeys would do, or some varieties of parrots than the freedom-loving sea-fowl.

At the Bishop's Gardens in Havana, Cuba, I remember very well a large aviary, in which were confined a considerable number of wild ducks, sea-gulls, and similar birds, and it was a delight to watch them, as they appeared to be fully as contented as in their native wilds, and would sport in the inclosed sheet of water, or preen themselves on the rocks, all day long. Then, some creatures bear being continually looked at better than others, while some have such highly nervous organizations that they should be placed only in the more secluded nooks of the garden, and even then have the means of withdrawing from the public gaze for at least a time. As owls never outgrow their fondness for a hollow stump, bears their climbing-poles, parrots their swing-boughs, and musk-rats their marsh-ways, we should make every endeavor to bring all our ingenuity to our aid in imitating as closely as possible in the gardens their natural conditions. The writer has during his lifetime kept a great many animals in confinement, of all manner of varieties, from a pocket gopher to an eagle, and from a ring-tailed howler-monkey to a turkey-buzzard, and has learned that, notwithstanding the creature may be abundantly supplied with his proper food, you can kill a star-nosed mole if you do not give him the opportunity to burrow in moist, wet ground; or render a porcupine utterly miserable if you do not serve him with the stump of an old tree, some ten feet above the ground, to stretch himself out upon.

Experience has taught us that the best way of exhibiting almost all kinds of reptiles, from the largest varieties of snakes and pythons down to the most diminutive species of lizards and hylas, is in that style of cage wherein the front and sides are formed of large single panes of clear glass. This allows an excellent view of the inmates, and full opportunity to watch and study their habits. On the other hand, the alligators, as representatives of this class, do best in a sluggish pool, with marshy banks, and with flat, mossy rocks and logs to bask themselves upon. Out at West End, in New Orleans, there is a small place of this kind, and the several large alligators I saw in it seemed to be as well contented as though they were enjoying the peculiar advantages of their native bayous; and, as common as these great reptiles are in Louisiana, those at West End always seemed to have more or fewer people intently watching them; and sometimes, even in the broiling noonday sun, one might see one of the oldest and most aristocratic residents of Royal Street stop there for a passing moment, just to "take a glance at the 'gators."

Throughout the garden the names of all the animals should be made known to the visitors by the managers seeing to it that the cages or other receptacles confining them are properly though not too conspicuously labeled. An excellent form of label is a small, water-tight, cast-iron, and painted one, with a glass-slide front. In this the white paper slip may be kept, upon which in plain black letters is printed the name of the animal—that is, its most common name—with its accepted technical name; and a brief statement giving sex and normal geographical range in nature.

However amusing it may be, it also has its other aspects, to see a party of some ten or a dozen people standing before a large tank-cage containing a pair of fur-seals, and, from the absence of a label, not a soul able to divine the name of the creatures contained in it; and perhaps, too, one or more ladies in the group with a seal sack on.

In a country like the United States, where a number of its finest mammals and some birds are rapidly becoming extinct, it devolves as a solemn duty upon the management of a zoölogical garden to secure a goodly representation of these for permanent preservation. Among the mammals which now need such action none is better known than the buffalo, though the Rocky Mountain goat (*Mazama*), the beaver, and several species of deer stand in the same case; indeed, I presume the day will come to this country when all of our larger mammals will cease to exist in a state of nature, and we shall have to depend upon our gardens and parks for examples of them. Of the birds, our Carolina parrot and roseate spoonbill are conspicuous examples, and it can be only a few years at most when both species will be extinct in this country.

Animals in a zoölogical garden should be grouped, so far as circumstances will admit, into their natural orders of the class to which they belong. For instance, all the dogs, wolves, and foxes, and their nearest allies, should be made to inhabit a den or dens in the same part of the garden, and in all cases special means should be adopted to point out the animals belonging to the country in which the garden is maintained. The system of labeling will do much toward this if carried out as suggested on a previous page; and if keepers and others are intelligent and obliging, as they surely should be, they can accomplish a great deal in a few words to groups of inquiring visitors.

Many questions touching upon special details in administration—as the best means to be adopted to secure desirable acquisitions to the garden, to the methods of exchange, of contracts for food, and similar matters, and whether or not it is desirable to make a small charge to visitors as an entrance-fee—hardly fall within the scope of the present article to discuss.

Modern architecture and artisanship, and present-day knowledge of sanitary engineering and sanitation, with our ever-increasing literature upon the diseases and their treatment in the lower animals, all leave but little to be desired for a superintendent of a zoölogical garden to draw upon for the application of their principles to the institution under his charge. If means be ample, there is not the shadow of excuse why such a place may not be made as inviting as the "gardens of the gods," and cleanliness and purity completely carried out.

One main building always constitutes an inseparable part of a model zoölogical garden, and it is devoted to the offices and study-rooms of the staff, to the lecture-room, to the reading-room and library, to the photographic gallery, to the laboratories and store-rooms, and, finally, to a few spare rooms for special purposes.

The lecture-room should be properly fitted up, and made to accommodate a large audience. Here, at certain seasons, a course of free lectures should be delivered on some branch of zoölogy or zoötomy, either by some resident member of the staff, or by specialists.

No well-appointed zoölogical building in connection with a garden would be complete without its reading-room and library. In the latter should be found, in time, all the standard works that have appeared upon the various branches of natural science, and more particularly upon vertebrate zoölogy and morphology, including, of course, such subjects as classification and geographical distribution of animals, and the reports of other zoölogical gardens and societies. On the reading-tables should appear the various authoritative zoölogical periodicals of the day, and bound volumes of the same should be upon the library shelves. It is an excellent idea to have the walls of such a room as this hung with strong relief maps of the various parts of the world, upon which are portrayed by clear defining lines the several regions as they are described by zoögraphers, showing the natural geographical distribution of animals. Within these areas there might be printed the names of the best-known representatives of the vertebrate kingdom that distinguish them. Such a series of maps or charts would be highly instructive to the visitor, useful at times in the lecture-room, and always a convenience to others.

Few departments will be more important than the photographic gallery, and it should be under the charge of a thoroughly competent photographer, who should also combine in his knowledge a familiarity with the habits of animals, and what is required of him through his art. He can be kept constantly at work photographing the rarer animals. Efforts should be constantly made to catch them in the act of any of their peculiar habits; pictures should be made of their young at all stages, the appearance of the dams at the various periods of gestation, the nesting of the various species of birds, and so on indefinitely. Further, he should be enabled to take photographs of special dissections of the prosector, and of casts and skeletons, and similar work. A full series of these photographs should be bound and kept on file in the collections of the establishment, as they will be of the very highest importance to the scientific taxidermist, artist, engraver, zoölogist, and others.

From one cause or another, a certain proportion of the animals die every year; and in the year 1887, in the London Gardens, for example, there were added twenty-five hundred and twenty-five animals of the three classes of vertebrates—quadrupeds, birds, and reptiles; and during the same year nine hundred and twenty-five died. Now, these dead animals are in the majority of cases of inestimable value, and no such material should ever be allowed to go to waste. It should come immediately under the charge of the prosector, so he may promptly direct what use is to be made of it. As a rule, it is not desirable for the garden to accumulate an anatomical collection, though it is highly useful for the prosector to have on hand preparations of certain forms; but, in the main, large skeletons or bodies of animals should be turned over to the city museums. In the case of duplicates, or where animals have died and their anatomical structure has been previously described, they may sometimes be sold or exchanged for living animals, or otherwise disposed of. Often small species can be at once consigned to alcohol, for the future use of the prosectorial department. Rare forms that are but slightly known morphologically should be thoroughly described and figured, either by the prosector or by special workers to whom such material may be sent for the purpose. These descriptions and figures should constitute the main feature of the published reports of the garden, and they should be got out in a style as handsome as printer and engraver can make them, and bound in a manner compatible with their importance and value. They will not make up, however, the entire quarterly report, as in it also will appear the engravings and descriptions of hitherto unfigured animals, and a general account of the quarterly proceedings of the entire establishment, and other matters of interest.

Thus it will be seen that the prosectorial department is one of the most important connected with the institution, and in due time will contribute to the common stock of scientific knowledge a mass of information of a peculiarly valuable character, and of a kind, as a rule, not easily obtainable in any other way.

Taken, then, in its entirety, a zoölogical garden, such as I have attempted to outline in this paper, has within its means to powerfully aid, encourage, and stimulate human progress, education, and science in an infinite variety of ways; and such an institution stands among the very best of investments to be made either on the part of State or city. Here are library, lecture, art, design, and interest for the multitude, and yet how rarely does it occur to the mind of the philanthropist to make an endowment in such a direction! Moneys diverted into such channels not only are given to the cause of education and learning and art, but to the embellishment of the city where the garden is founded, to the interest of its people, and the perpetuation of the name of the donor. Zoölogical gardens, again, even exert a far more powerful influence toward luring those of certain classes and conditions away from the vices of a city than does the museum or the library; while, with others, it leads to a greater interest and appreciation of the other establishments and their advantages.

With respect to a nation as a whole that has arrived at a certain height of civilization, and can boast of a well-filled treasury, it almost, if not quite, becomes her bounden duty to her people, and to the common good, to endow such an institution at her national capital, in connection with other scientific departments, of which she is the supporter in chief. And it should be the pride of every intelligent citizen of such a nation to see to it, as far as he is individually able, that the capital of his country is not backward in such matters, especially when he comes to look about him and sees that the most distinguished and influential nations of the earth are characterized by possessing just such institutions at the seat of their national governments.

THE International Geological Congress map of northern Germany, which is in proof, is to be printed in twenty-four different tints for the sedimentary formations, three for the archæan, and nine for the eruptive rocks, and will consist of forty-nine sheets. One color is taken for each group—Cretaceous, green; Jurassic, blue, etc. The subdivisions are shown by various modifications of these colors. As a rule, the lower subdivisions are shown by the darker tints.

THE DERIVATIVE ORIGIN OF THE HUMAN MIND.*

By G. J. ROMANES, F. R. S.

IF it is true that "the proper study of mankind is man," assuredly the study of nature has never before reached a territory of thought so important in all its aspects as that which in our own generation it is for the first time approaching. After centuries of intellectual conquest in all regions of the phenomenal universe, man has at last begun to find that he may apply in a new and most unexpected manner the adage of antiquity—*Know thyself*. For he has begun to perceive a strong probability, if not an actual certainty, that his own living nature is identical in kind with the nature of all other life, and that even the most amazing side of this his own nature—nay, the most amazing of all things within the reach of his knowledge—the human mind itself, is but the topmost inflorescence of one mighty growth, whose roots and stem and many branches are sunk in the abyss of planetary time. Therefore, with Prof. Huxley we may say: "The importance of such an inquiry is indeed intuitively manifest. Brought face to face with these blurred copies of himself, the least thoughtful of men is conscious of a certain shock, due perhaps not so much to disgust at the aspect of what looks like an insulting caricature, as to the awaking of a sudden and profound mistrust of time-honored theories and strongly rooted prejudices regarding his own position in nature, and his relations to the wider world of life; while that which remains a dim suspicion for the unthinking, becomes a vast argument, fraught with the deepest consequences, for all who are acquainted with the recent progress of anatomical and physiological sciences." †

The problem, then, which in this generation has for the first time been presented to human thought, is the problem of how this thought itself has come to be. A question of the deepest importance to every system of philosophy has been raised by the study of biology; and it is the question whether the mind of man is essentially the same as the mind of the lower animals, or, having had, either wholly or in part, some other mode of origin, is essentially distinct—differing not only in degree but in kind from all other types of psychical being. And forasmuch as upon this great and deeply interesting question opinions are still much divided—even among those most eminent in the walks of science who agree in accepting the principles of evolution as applied to explain the mental constitution of the lower animals—it is evident that the

* From "Mental Evolution in Man." By George John Romanes, LL. D., F. R. S. New York: D. Appleton & Co., 1889.

† "Man's Place in Nature," p. 59.

question is neither a superficial nor an easy one. I shall, however, endeavor to examine it with as little obscurity as possible, and also, I need hardly say, with all the impartiality of which I am capable.*

It will be remembered that in the introductory chapter of my previous work † I have already briefly sketched the manner in which I propose to treat this question. Here, therefore, it is sufficient to remark that I began by assuming the truth of the general theory of descent so far as the animal kingdom is concerned, both with respect to bodily and to mental organization; but in doing this I expressly excluded the mental organization of man, as being a department of comparative psychology with reference to which I did not feel entitled to assume the principles of evolution. The reason why I made this special exception, I sufficiently explained; and I shall therefore now proceed, without further introduction, to a full consideration of the problem that is before us.

First, let us consider the question on purely *a priori* grounds. In accordance with our original hypothesis—upon which all naturalists of any standing are nowadays agreed—the process of organic and of mental evolution has been continuous throughout the whole region of life and of mind, with the one exception of the mind of man. On grounds of analogy, therefore, we should deem it antecedently improbable that the process of evolution, elsewhere so uniform and ubiquitous, should have been interrupted at its terminal phase. And looking to the very large extent of this analogy, the antecedent presumption which it raises is so considerable, that in my opinion it could only be counterbalanced by some very cogent and unmistakable facts, showing a difference between animal and human psychology so distinctive as to render it in the nature of the case virtually impossible that the one could ever have graduated into the other. This I posit as the first consideration.

Next, still restricting ourselves to an *a priori* view, it is unquestionable that human psychology, in the case of every individual human being, presents to actual observation a process of gradual development, or evolution, extending from infancy to manhood; and that in this process, which begins at a zero level of mental

* It is perhaps desirable to explain from the first that by the words "difference of kind," as used in the above paragraph and elsewhere throughout this treatise, I mean difference of *origin*. This is the only real distinction that can be drawn between the terms "difference of kind" and "difference of degree"; and I should scarcely have deemed it worth while to give the definition, had it not been for the confused manner in which the terms are used by some writers—e. g., Prof. Sayce, who says, while speaking of the development of languages from a common source, "differences of degree become in time differences of kind" ("Introduction to the Science of Language," ii, 309).

† "Mental Evolution in Animals."

life and may culminate in genius, there is nowhere and never observable a sudden leap of progress, such as the passage from one order of psychical being to another might reasonably be expected to show. Therefore, it is a matter of observable fact that, whether or not human intelligence differs from animal in kind, it certainly does admit of gradual development from a zero level. This I posit as the second consideration.

Again, so long as it is passing through the lower phases of its development, the human mind assuredly ascends through a scale of mental faculties which are parallel with those that are permanently presented by the psychological species of the animal kingdom. A glance at the accompanying diagram will serve to show in how strikingly quantitative, as well as qualitative, a manner the development of an individual human mind follows the order of mental evolution in the animal kingdom. And when we remember that, at all events up to the level where this parallel ends, the diagram is not an expression of any psychological theory, but of well-observed and undeniable psychological fact, I think every reasonable man must allow that, whatever the explanation of this remarkable coincidence may be, it certainly must admit of *some* explanation—i. e., can not be ascribed to mere chance. But, if so, the only explanation available is that which is furnished by the theory of descent. These facts, which I present as a third consideration, tend still further—and, I think, most strongly—to increase the force of antecedent presumption against any hypothesis which supposes that the process of evolution can have been discontinuous in the region of mind.

Lastly, it is likewise a matter of observation, as I shall fully show in the next installment of this work, that in the history of our race—as recorded in documents, traditions, antiquarian remains, and flint implements—the intelligence of the race has been subject to a steady process of gradual development. The force of this consideration lies in its proving that, if the process of mental evolution was suspended between the anthropoid apes and primitive man, it was again resumed with primitive man, and has since continued as uninterruptedly in the human species as it previously did in the animal species. Now, upon the face of these facts, or from a merely antecedent point of view, such appears to me, to say the least, a highly improbable supposition. At all events, it certainly is not the kind of supposition which men of science are disposed to regard with favor elsewhere; for a long and arduous experience has taught us that the most paying kind of supposition which we can bring with us into our study of nature, is that which recognizes in nature the principle of *continuity*.

Taking, then, these several *a priori* considerations together, they must, in my opinion, be fairly held to make out a very strong *prima facie* case in favor of the view that there has been no interruption of the developmental process in the course of psychological history; but that the mind of man, like the mind of animals—and, indeed, like everything else in the domain of living nature—has been evolved. For these considerations show, not only that on analogical grounds any such interruption must be held as in itself improbable; but also that there is nothing in the constitution of the human mind incompatible with the supposition of its having been slowly evolved, seeing that not only in the case of every individual life, but also during the whole history of our species, the human mind actually *does* undergo, and *has* undergone, the process in question.

In order to overturn so immense a presumption as is thus erected on *a priori* grounds, the psychologist must fairly be called upon to supply some very powerful considerations of an *a posteriori* kind, tending to show that there is something in the constitution of the human mind which renders it virtually impossible—or at all events exceedingly difficult to imagine—that it can have proceeded by way of genetic descent from mind of lower orders. I shall therefore proceed to consider, as carefully and as impartially as I can, the arguments which have been adduced in support of this thesis.

In the introductory chapter of my previous work * I observed that the question whether or not human intelligence has been evolved from animal intelligence can only be dealt with scientifically by comparing the one with the other, in order to ascertain the points wherein they agree and the points wherein they differ. I shall, therefore, here begin by briefly stating the points of agreement, and then proceed more carefully to consider all the more important views which have hitherto been propounded concerning the points of difference.

If we have regard to emotions as these occur in the brute, we can not fail to be struck by the broad fact that the area of psychology which they cover is so nearly coextensive with that which is covered by the emotional faculties of man. In my previous works I have given what I consider unquestionable evidence of all the following emotions, which I here name in the order of their appearance through the psychological scale—fear, surprise, affection, pugnacity, curiosity, jealousy, anger, play, sympathy, emulation, pride, resentment, emotion of the beautiful, grief, hate, cruelty, benevolence, revenge, rage, shame, regret, deceitfulness, emotion of the ludicrous.†

Now, this list exhausts all the human emotions, with the exception of those which refer to religion, moral sense, and perception

* "Mental Evolution in Animals."

† See "Mental Evolution in Animals," chapter on the Emotions.

of the sublime. Therefore I think we are fully entitled to conclude that, so far as emotions are concerned, it can not be said that the facts of animal psychology raise any difficulties against the theory of descent. On the contrary, the emotional life of animals is so strikingly similar to the emotional life of man—and especially of young children—that I think the similarity ought fairly to be taken as direct evidence of a genetic continuity between them.

And so it is with regard to instinct. Understanding this term in the sense previously defined,* it is unquestionably true that in man—especially during the periods of infancy and youth—sundry well-marked instincts are presented, which have reference chiefly to nutrition, self-preservation, reproduction, and the rearing of progeny. No one has ventured to dispute that all these instincts are identical with those which we observe in the lower animals; nor, on the other hand, has any one ventured to suggest that there is any instinct which can be said to be peculiar to man, unless the moral and religious sentiments are taken to be of the nature of instincts. And although it is true that instinct plays a larger part in the psychology of many animals than it does in the psychology of man, this fact is plainly of no importance in the present connection, where we are concerned only with identity of principle. If any one were childish enough to argue that the mind of a man differs in kind from that of a brute because it does not display any particular instinct—such, for example, as the spinning of webs, the building of nests, or the incubation of eggs—the answer of course would be that, by parity of reasoning, the mind of a spider must be held to differ in kind from that of a bird. So far, then, as instincts and emotions are concerned, the parallel before us is much too close to admit of any argument on the opposite side.

With regard to volition more will be said in a future installment of this work. Here, therefore, it is enough to say, in general terms, that no one has seriously questioned the identity of kind between the animal and the human will, up to the point at which so-called freedom is supposed by some dissentients to supervene and characterize the latter. Now, of course, if the human will differs from the animal will in any important feature or attribute such as this, the fact must be duly taken into account during the course of our subsequent analysis. At present, however, we are only engaged upon a preliminary sketch of the points of resem-

* "Mental Evolution in Animals," p. 159. "The term is a generic one, comprising all the faculties of mind which are concerned in conscious and adaptive action, antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently recurring circumstances by all individuals of the same species."

blance between animal and human psychology. So far, therefore, as we are now concerned with the will, we have only to note that up to the point where the volitions of a man begin to surpass those of a brute in respect of complexity, refinement, and foresight, no one disputes identity of kind.

Lastly, the same remark applies to the faculties of intellect.* Enormous as the difference undoubtedly is between these faculties in the two cases, the difference is conceded not to be one of kind *ab initio.* On the contrary, it is conceded that up to a certain point—namely, as far as the highest degree of intelligence to which an animal attains—there is not merely a similarity of kind but an identity of correspondence. In other words, the parallel between animal and human intelligence which is presented in the diagram is not disputed. The question, therefore, only arises with reference to those superadded faculties which are represented above the level marked twenty-eight, where the upward growth of animal intelligence ends, and the growth of distinctively human intelligence begins. But even at level twenty-eight the human mind is already in possession of many of its most useful faculties, and these it does not afterward shed, but carries them upward with it in the course of its further development—as we well know by observing the psychogenesis of every child. Now, it belongs to the very essence of evolution, considered as a process, that when one order of existence passes on to higher grades of excellence, it does so upon the foundation already laid by the previous course of its progress; so that when compared with any allied order of existence which has not been carried so far in this upward course, a more or less close parallel admits of being traced between the two, up to the point at which the one begins to distance the other, where all further comparison admittedly ends. Therefore, upon the face of them, the facts of comparative psychology now before us are, to say the least, strongly suggestive of the superadded powers of the human intellect having been due to a process of evolution.

Lest it should be thought that in this preliminary sketch of the resemblances between human and brute psychology I have been endeavoring to draw the lines with a biased hand, I will here quote a short passage to show that I have not misrepresented the extent to which agreement prevails among adherents of otherwise

* Of course, my opponents will not allow that this word can be properly applied to the psychology of any brute. But I am not now using it in a question-begging sense: I am using it only to avoid the otherwise necessary expedient of coining a new term. Whatever view we may take as to the relations between human and animal psychology, we must in some way distinguish between the different ingredients of each, and so between the instinct, the emotion, and the intelligence of an animal. (See "Mental Evolution in Animals," p. 335 *et seq.*)

opposite opinions. And for this purpose I select as spokesman a distinguished naturalist, who is also an able psychologist, and to whom, therefore, I shall afterward have occasion frequently to refer, as on both these accounts the most competent as well as the most representative of my opponents. In his presidential address before the Biological Section of the British Association in 1879, Mr. Mivart is reported to have said:

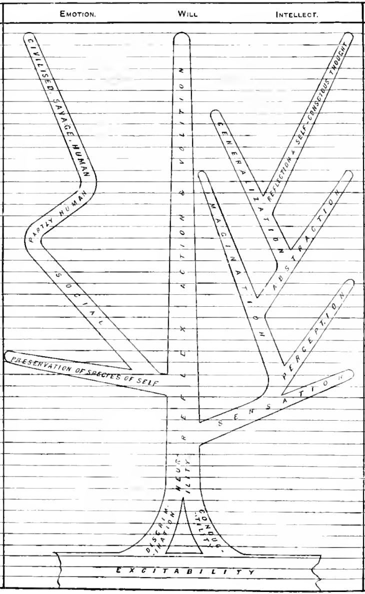
"I have no wish to ignore the marvelous powers of animals, or the resemblance of their actions to those of man. No one can reasonably deny that many of them have feelings, emotions, and sense-perceptions similar to our own; that they exercise voluntary motion, and perform actions grouped in complex ways for definite ends; that they to a certain extent learn by experience, and combine perceptions and reminiscences so as to draw practical inferences, directly apprehending objects standing in different relations one to another, so that, in a sense, they may be said to apprehend relations. They will show hesitation, ending apparently, after a conflict of desires, with what looks like choice or volition; and such animals as the dog will not only exhibit the most marvelous fidelity and affection, but will also manifest evident signs of shame, which may seem the outcome of incipient moral perceptions. It is no great wonder, then, that so many persons, little given to patient and careful introspection, should fail to perceive any radical distinction between a nature thus gifted and the intellectual nature of man."

SCIENCE AND "CHRISTIAN SCIENCE."

By FREDERIK A. FERNALD.

THE doctrine known as Christian Science has gained so large a number of followers, it promises the freedom from disease which so many afflicted persons are longing for, it appeals to the religious sentiments, which are so powerful to sway the mass of mankind, and also claims a basis in science from which the world is constantly expecting fresh surprises, that it has aroused the interest of thousands who are trying to decide whether it is a revelation of truth or a contagious delusion.

Christian Science was "discovered" by Mrs. Mary B. Eddy, then of Lynn, Mass., in 1866. The leading features of her doctrine are that "everything is Mind," that there is but one Mind, which is God, and that "man is the idea of God." Our bodies, and the things around us, houses and furniture, trees, rocks, and earth—all things composed of matter—do not really exist, but are only the ideas of mind, something like the things of a dream. Matter,



	Products of Emotional Development		Products of Intellectual Development	The Psychological Scale	Psychogenesis of Man	
50		50				50
49		49				49
48		48				48
47		47				47
46		46				46
45		45				45
44		44				44
43		43				43
42		42				42
41		41				41
40		40				40
39		39				39
38		38				38
37		37				37
36		36				36
35		35				35
34		34				34
33		33				33
32		32				32
31		31				31
30		30				30
29		29				29
28	Shame, Remorse, Deceitfulness, Ludicrous	28	Indefinite morality	Anthropoid Apes and Dog	15 months	28
27	Revenge, Rage	27	Use of tools	Monkeys and Elephant	12 months	27
26	Grief, Hate, Cruelty, Benevolence	26	Understanding of mechanism	Carnivora, Rodents, and Ruminants	10 months	26
25	Emulation, Pride, Resentment, Æsthetic love of ornament, Terror	25	Recognition of Pictures, Understanding of words, Dreaming	Birds	8 months	25
24	Sympathy	24	Communication of ideas	Hymenoptera	5 months	24
23		23	Recognition of persons	Reptiles and Cephalopods	4 months	23
22	Affection	22	Reason	Higher Crustacea	14 weeks.	22
21	Jealousy, Anger, Play	21	Association by similarity	Fish and Batrachia	12 weeks	21
20	Parental affection, Social feelings, Sexual selection, Pugnacity, Industry, Curiosity	20	Recognition of offspring, Secondary instincts	Insects and Spiders	10 weeks	20
19	Sexual emotions without sexual selection	19	Association by contiguity	Mollusca	7 weeks	19
18	Surprise, Fear	18	Primary instincts	Larvæ of Insects, Annelida	3 weeks	18
17		17	Memory	Echinodermata	1 week	17
16		16	Pleasures and pains		Birth	16
15		15	Consciousness	Cœlenterata		15
14		14	Nervous adjustment			14
13		13				13
12		12		Unknown animals		12
11		11	Partly nervous adjustments	probably Cœlenterata		11
10		10		perhaps extinct	Embryo	10
9		9				9
8		8				8
7		7	Non-nervous adjustments	Unicellular organisms		7
6		6				6
5		5				5
4		4				4
3		3	Protoplasmic movements.	Protoplasmic organisms.	Ovum and	3
2		2				2
1		1			Spermatozoa	1

being unreal, can not feel or know anything, and hence can not be sick; and mind, being divine, is perfect, and hence can not be sick either. Therefore, there can be no sickness in anything, and what we call sickness is only a belief—not a belief of the one Divine Mind, but a belief of what she calls "mortal mind," which is itself unreal. Hence, when the belief is destroyed, the disease is destroyed also. She deems this theory fully verified, because, proceeding in accordance with it, she states that she has "prevented disease, preserved and restored health, healed chronic as well as acute ailments in their severest forms, elongated shortened limbs, relaxed rigid muscles, restored decaying bones to healthy conditions, brought back the lost substance of the lungs, and caused them to resume their proper functions." She asserts that sin is an error of similar nature with disease, and yields to similar treatment. "Healing the sick and reforming the sinner are one and the same thing in Christian Science." Death also is all a mistake. The doctrine is set forth very fully in Mrs. Eddy's book, "Science and Health," of which over thirty thousand copies have been sold. Many other books and pamphlets have been published by the Christian Scientists, and they issue a number of periodicals, the chief of which are: "The Christian Science Journal" and "The Mental Healing Monthly," in Boston; "The International Magazine of Christian Science," in New York; and "The Mental Science Magazine" and "The Christian Metaphysician," in Chicago. In each of these cities there are several "schools," "institutes," and "universities" for the teaching of "Christian Science," or "metaphysical healing," or the "science of spirit," or "Christian pneumatopathy," or essentially the same thing by some other name; and there are one or more such institutions in a number of other cities.

The two parts of the name "Christian Science" indicate that the doctrine has a mixed character. As to the genuineness of its Christianity, the doctors of divinity are best qualified to judge; the religious side of the subject lies outside the domain of science, and will not be treated here. I will only say that the garb of religion has often been a convenient cloak for fraud and delusion. But Mrs. Eddy calls her system of healing a science. If it really has the character of a science, it will endure all the tests that a genuine science will endure. If Christian Science is true, not only should cures always result when its precepts are followed, but, when a part of the theory is disregarded, failure should be sure to result. Any mental healer who tried to cure disease without denying that disease exists, or without denying that matter exists, or without asserting that all mind is one, should meet with discomfiture and defeat. In the case of a genuine scientific doctrine, such as the law of gravitation, any operation like the erection of a tower or the calculation of the path of a cannon-ball will result in success or failure according as it is or is not performed in complete agreement with this law.

Now, the Christian Scientists are continually making failures. Patients whom they have treated for a long time still have poor health. The healers plead that these patients have been helped some, but the gain is doubtful; and, besides, their theory does not leave room for any partial successes. "The rule, and its perfectness in my system, never vary," says Mrs. Eddy. There are other patients who might have been numbered among the successes of Christian Science if they had not unfortunately died under the treatment. Such instances furnish frequent items for the newspapers. "The Medical and Surgical Reporter" gives this case: The wife of a physician in Cincinnati had a cancer. The growth was removed, but after some months the disease reappeared, and everything that the best medical skill of the country could do for the patient proved in vain. She was urged to try the faith-cure, but her husband naturally refused to allow this. When, however, it began to be whispered about that, because she was married to a physician, she must die for want of freedom to avail herself of all methods of cure, he could resist no longer. Under his protest she went to the faith-healers, and every day they told her that she was getting better, while she was really growing worse, and soon died.

"The New York Herald" prints the following:

> *Chicago, Ill., February 21, 1888.*—F. Benedict, late an employé at W. W. Kimball & Company's piano ware-rooms, lies dead in the La Burnham flats, a victim to "faith-healing," and to-morrow Dr. C. R. Teed, the editor of the Christian Science organ, "The Guiding Star," will be called upon to answer charges of criminal malpractice in connection with the case.

From the "Boston Herald" I learn that Mrs. Lottie A. James, of West Medford, Mass., died April 20, 1888, in childbirth, under the treatment of her mother, who was a Christian Scientist. The child also died. Her husband was absent. The mother was charged with manslaughter, but the grand jury failed to indict her. The following item appeared in the "New York Tribune":

> *Springfield, Mo., May 28th.*—Mrs. John Truesdale last night drowned herself in a reservoir. She had acted strangely for the last two or three weeks, owing to strict adherence to the teachings of a Christian Scientist, James Reed. He told Mrs. Truesdale that he could teach her the science of healing by prayer so that she could heal her husband, who is an engineer, but has been ill with consumption for several months. Grasping at anything that promised any hope for her husband, she visited Reed frequently, and the general opinion is that out of her experience grew the despair that caused her to kill herself.

Still another case was reported in "The New York Times":

Chicago, May 30th.—There is another unpleasant case for the faith-healers to explain. Mrs. Mary Reiter, a young woman, came to this city from Valparaiso, Ind., recently, suffering from pulmonary troubles, and put herself under the care of Mrs. J. C. Barker, a Christian Scientist, for treatment. She died last night, and the faith-healer being unable to give a death-certificate, the coroner to-day took up the case.

Like Dr. Frog in the fable, these physicians also fail to cure themselves. Arlo Bates writes to the "Providence Journal" that a prominent Boston dentist was called from his bed at two o'clock one morning to go to the relief of a lady who was suffering the agonies of toothache. He at first declined to go, but finally went, relieved her pain, and went again in the daytime to do something more to the teeth. He had not taken much notice of the name given him at his first visit, but on reaching the house the second time his eye fell on the door-plate, and he found that he had been called in such hot haste to relieve the pain of one who makes a handsome income by teaching that there is no such thing as pain. His patient was a shining light of Christian Science, but she could not cure her own toothache!

Mr. Charles M. Barrows mentions the following cases in his "Facts and Fictions of Mental Healing": "About three years ago a well-known citizen of Boston was thoroughly cured, to all appearance, of a distressing chronic malady, and embraced the doctrines advocated by his healer, a 'Christian Scientist.' He also became a very successful healer of others, and was so confident in his own ability to resist disease that he frequently declared it was impossible for him ever to be sick. Yet within a twelvemonth this same man, who sincerely thought he had risen superior to all finite ills, was hurried to the grave by a hæmorrhage of the lungs. During the past year four active mental healers have succumbed to the fell destroyer of mortal life; and only last summer one of the great lights of 'Christian Science' was prostrated with nervous exhaustion and obliged to seek medical aid."

Any theory of physics or chemistry which admitted of such utter failures as Christian Science suffers would be pronounced, even by its friends, unworthy the name of science. Mrs. Eddy does not take these failures as indications that her theory needs modifying, but throws the blame of them upon her luckless disciples. She says to her pupils, "If you fail to succeed in any case, it is because you have not demonstrated the rule and proved the principle." She and her theory remain infallible, but she has avoided inconvenient tests of her own powers of late years, and prints in her book this note: "The authoress takes no patients, and has no time for medical consultation." As president of the "Massachusetts Metaphysical College," she doubtless feels that her time is more profitably used, and her luxurious home on Boston's finest avenue testifies to the magnitude of the profits.

If Mrs. Eddy can claim that failures are sufficient proof that the healer does not practice the right method, she must likewise accept success as sufficient proof that the healer does practice the right method. Now there are several *different methods*. Although she denounces as heresy any deviation from her doctrine, yet some of her former disciples, who do not hold that every person's mind is a part of the Divine Being, have success in healing that will compare favorably with that of the faithful. Hence this part of Mrs. Eddy's doctrine is of no consequence in healing. These heretics prefer to be called "mental healers." Then there is the faith-cure, with its "Beth-shan," in London, its conventions at Old Orchard, Maine, and its sanctuary in Jersey City. It has also been used somewhat in England by the Salvation Army. The theory of the faith-curers is simply an extension of the Christian's belief in the efficacy of prayer for the sick. They do not assert that matter is unreal, and that nothing exists but mind, yet they perform enough cures to show that this part also of Mrs. Eddy's doctrine is of no consequence in the practice of healing.

A variety of faith-healing has been practiced in the Roman Catholic Church for hundreds of years. There is plenty of testimony, as good as the Christian Scientists can furnish, that persons have been healed by the aid of the prayers of priests and bishops, by touching the bones or other relics of saints, or by bathing in the water of sacred springs. A noted locality for such cures at the present time is the grotto of Lourdes in France. The Mormons are not behind the Catholics or Protestants in making cures. One of the chief methods employed by their missionaries in gaining converts is to pray with the sick, who often recover and join the sect. The cures credited to the wonderful Dr. Newton, who flourished twenty-five to thirty years ago, as well as those which gained Dr. Perkins's "tractors" their fame at the close of the last century, must be counted as mental healing. Hence, there have been successful mind-curers before Mrs. Eddy, although their theories agreed in little or nothing with hers. In fact, from the teachings of one of the irregular healers who preceded her, Mr. P. P. Quimby, Mrs. Eddy is charged with appropriating everything of importance in her system. This charge she indignantly denies.

Moreover, cures have been effected when healer and patient held a belief that was demonstrably *false*. Prince Radzivil, of

Lithuania, visiting Rome at the time of the Reformation, received from the pope a box of precious relics. After he reached home the relics were used by the monks for the cure of a demoniac, who had held out against every kind of exorcism. The success was instantaneous and complete. But the prince observed a knowing smile on the face of the young man who had been keeper of the relics, and upon inquiry learned to his disgust that the genuine relics had been lost on the journey, and their place had been supplied with bones of cats and dogs picked up by the road. This lot of rubbish it was that had performed the miracle. Any one who believed that the touch of Queen Victoria's hand could cure him of scrofula (king's evil) would be unanimously declared out of his mind; yet it was the general belief in England for seven hundred years, from the reign of Edward the Confessor to that of Queen Anne, that the touch of the royal hand could heal this disease. Historians and physicians of the time testify to the usual success of the operation. Every one has read of the noisy antics employed by the medicine-men among the Indians, and by the fetich-doctors and voodoos among the negroes, for driving diseases out of their patients. Explorers and missionaries report that surprising cures often follow such treatment. No Christian Scientist would acknowledge fellowship with these ignorant impostors, and yet the voodoos cure disease without material means like the disciples of Mrs. Eddy.

I do not wish to be understood as giving full credit to all the reports of cures by any of these agencies. Doubtless in many instances the recovery is spontaneous; it is effected by the healing power of nature, and in spite of the treatment rather than by means of it. The patients would have got well as soon or sooner if nothing had been done for them. Moreover, in many cases reported by persons with little medical knowledge, the disease was not as serious, and hence the cure was not as wonderful, as is represented. Still, there remains enough evidence to show that in each one of the above ways real disease has been thrown off by aid of mental influence.

Furthermore, disease has been cured, with no theory of treatment whatever, by an *accidental* impression made on the mind. Mr. Barrows tells the following: The wife of a wealthy Pennsylvania farmer had been bedridden for many years, and unable to rise or walk without help. A Baptist minister visited the family, and the host showed him about his thrifty farm, in which he evidently took an honest pride. "Your farm seems to be one of the best in this section," observed the guest. "Yes, it is, sir," answered the host, with a beaming face; "and, what is more, it's all paid for." Similar comments on the barns, stock, etc., brought forth assurances that they, too, were "all paid for." Dinner-time came, and the family, with their guest, gathered at the table. The invalid occupied a bedroom adjoining the dining-room, in order that when the family were at table she might hear their conversation through the open door. The clergyman was asked to say grace, and began thus:

"O Lord, we thank thee for the abundance now spread before us; we thank thee that it is all paid for—"

Here a sudden interruption came from the invalid in the next room, who, on hearing her husband's pet phrase put into a prayer, burst into a fit of uncontrollable laughter. Entirely forgetting her condition, she sprang out of bed, and stood holding her sides and shaking all over with mirth when the family rushed in. That solemn joke cured her, leaving nothing to be paid for. The same author tells of a New Hampshire lady who was also cured after being bedridden for a long time. In pleasant weather her grown-up sons used to lift their mother tenderly into a carriage, and take her for a drive. It was their opinion, however, that her case demanded heroic treatment, and they resolved to make the experiment. Near the house a brook crossed the road, through which they often drove to let the horse drink, instead of crossing by the bridge. The ford was usually safe and easy; but one day the carriage was suddenly upset by some stones previously placed in the water by the boys, and the invalid was thrown into the middle of the stream, from which she must scramble out or drown. She fathomed the well-meant plot, and was very angry; but the remedy was effectual, and her lameness was cured on the spot. A lady in California, who had suffered much from neuralgia and become blind, on hearing an alarm of fire regained her sight. Accidental mental excitement caused by explosions at the cartridge-factory in Bridgeport, Conn., has cured many cases of intermittent fever. A physician, writing to the "Medical News," tells of a man being cured of a chronic rheumatism, and another of nervous exhaustion, by the earthquake-shock at Charleston.

Hence we see that disease can be cured through the mind in a great variety of ways. The true science of mind-cure will explain all of them, but Mrs. Eddy's doctrine does not satisfy this condition. Moreover, hers is a complicated theory; and experience has shown that in science, where the facts can be explained in a simpler way, a complicated theory is likely to be false. Furthermore, a theory which, like Mrs. Eddy's, contradicts scientific laws that we see proved true every day of our lives, can not itself be true also. If her "Science" were to become established, all that we now know as science would have to be abandoned as inconsistent with it. Not only would the science of physiology, which she directly attacks, be destroyed, but the sciences of physics, chemistry, zoölogy, botany, astronomy, and geology would also be reduced to chaos, for these together with physiology are based on observation and induction, which Mrs. Eddy declares we can not trust. "Christian Science eschews what is termed natural science," she says, and she condemns the use of observation when she asserts that "it is morally wrong to examine the body in order to ascertain if we are in health." "Putting on the full armor of physiology, and obeying to the letter the so-called laws of health (so the statistics show), have neither diminished sickness nor lengthened life"! On the other hand, she affirms that "science is the watchword of our day," and calls attention to some of its benefits; in another place she indorses the results of astronomy. But that she is wofully ignorant of science is shown by such expressions as, "The angle of incidence is the reverse of the angles in the objects reflected"; "The blind forces called attraction, adhesion, and cohesion are not substances of matter"; "We tread on forces. Withdraw them, and the universe would collapse."

The genuine science of mental therapeutics is a very simple one. It has been discovered by physicians here and there at various times, and, if not adequately developed, it at least does not contradict the principles on which all science is based. The theory is, that mental impressions, however produced, act through the nervous system upon the various organs of the body so as to stimulate or obstruct their functions as the case may be. Such mental action is a matter of common observation. Whenever the cheek flushes with embarrassment or pales with fear, mental influence is producing its effect on the body. Great anxiety or grief causes loss of appetite, and may bring on an attack of dyspepsia or any other disease to which the person is liable. Fright has turned the hair gray in a few hours. Dr. Murchison wrote: "That jaundice may have a nervous origin has long been known. There are numerous instances on record of its being produced by severe mental emotions, such as fits of anger, fear, shame, or great bodily suffering."

Dr. Durand, of New Orleans, according to the "Picayune" of that city, recently made a test of mental influence by giving a hundred patients a dose of sweetened water. Fifteen minutes after, entering apparently in great excitement, he announced that he had by mistake given a powerful emetic, and preparations must be made accordingly. Eighty out of the hundred patients soon fell to vomiting.

On the other hand, the tonic effects on a patient of hope, cheerfulness, and a determination to get well, have been frequently commented upon, and many intelligent physicians have made good use of such mental aids in practice. Dr. John Hunter wrote a century ago, "There is not a natural action in the body, whether involuntary or voluntary, that may not be influenced by the peculiar state of the mind at the time." The chief store-house of facts of this class is Dr. D. Hack Tuke's work on "The Influence of the Mind upon the Body in Health and Disease" (London, 1872), his attention having been called to the subject in 1869 by a newspaper article on "The Curative Effects of a Railway Collision." The evidence furnished by Tuke and other writers leaves no room to doubt that mental action is a powerful agency which can be applied in the cure of disease.

Dr. Tuke says, in the preface to his classic work: "There are two classes of readers to whom I wish more especially to address myself. The medical reader who, I hope, may be induced to employ psycho-therapeutics in a more methodical way than heretofore, and thus copy nature in those interesting instances, occasionally occurring, of sudden recovery from the spontaneous action of some powerful moral cause, by employing the same force designedly, instead of leaving it to mere chance. The force is there, acting irregularly and capriciously. The question is, whether it can not be applied and guided with skill and wisdom by the physician. . . . 'Remember,' said Dr. Rush, in addressing medical students, 'how many of our most useful remedies have been discovered by quacks. Do not be afraid, therefore, of conversing with them, and of profiting by their ignorance and temerity.'" Not only when disguised under some pretentious and illogical quackery has the mental force been employed, but it has already been utilized, with a full appreciation of its nature, by physicians of high standing. Sir Humphry Davy's cure of a case of paralysis by repeated applications of a thermometer is a much-quoted instance.

In a paper entitled "Bodily Conditions as related to Mental States" ("Popular Science Monthly," vol. xv, page 40), Dr. C. F. Taylor, of New York, reports the case of a young man sent to him from a Western city. Dr. Taylor was informed that the patient had broken his thigh-bone two years before, that this fracture had united, but that a year later the same bone had been broken in another place. The regular treatment had failed to secure a union of the second fracture. On examination, Dr. Taylor found the muscles of the leg wasted and soft, with a large outward bending in the middle of the bone, but he could not find the slightest evidence that *any second fracture had occurred.* The patient *thought* he had refractured his thigh-bone, and this impression caused him quite unconsciously to withhold muscular action in the limb so completely that a relaxed and powerless condition was caused, which was mistaken for a broken bone. A mere explanation of his condition was not sufficient to enable him to relax his mental hold on the limb. Dr. Taylor caused the young man to take certain exercises with his arms, of so violent a character that they absorbed all his attention, leaving none for his lower limbs. Within three days he gave up restraining the injured leg, and he began to walk involuntarily. In this case it was the mind which needed treatment. A young lady was sent to Dr. Taylor from Albany for a supposed partial paralysis of the left foot and ankle, which caused her to drop her toes in walking. Her trouble proved to be entirely mental, and she was cured within ten days by restoring consciousness of power in the affected foot. He gives other cases to show that mental influence over bodily function causes not only loss of muscular power, but also increased muscular action simulating muscular spasm, increased or diminished bodily sensations, and disorders in the involuntary processes of life. His experience indicates that in such cases treatment directed toward the mind is the only sort that can be effective. He only alludes to "the important subject of mental influence on actual disease" in this article. "Suffice it here to say," he remarks, "that, as must be inferred from the facts and arguments already adduced, no system of therapeutics can be complete which does not embrace the design of controlling psychobiological relations in general, and with reference to chronic diseases especially."

Prof. G. Buchanan, of Glasgow, has placed on record cases of the same nature as these described by Dr. Taylor. Still others are related by Walter Moxon ("Contemporary Review," vol. xlviii, p. 707) and by other writers. Animal magnetism, first brought forward as a healing agency by Mesmer a century ago, has since been studied scientifically under the name of hypnotism. The work of these later investigators has established the fact that a large number of functional diseases are benefited, and even permanently cured, through the mind by hypnotic suggestion.

Now, in view of what has been done in curing disease by the aid of mental influence, the public has a right to demand that our physicians shall give us the benefit of this healing agency. Mental influence is a pleasant and inexpensive medicine; it cures in some cases where drugs fail, and it shortens the term of sickness and lightens its pains in many other cases; furthermore, it has no injurious incidental effects. But the mind-cure should be taken out of the hands of the untrained and irresponsible visionaries and the impostors who now practice it, or it will add a terrible amount of suffering and death to what it has already caused. These enthusiasts, carried away by their seeming successes in a few cases, insist that the mind-cure is the only treatment that is worth anything in all diseases and for all persons. They know too little about the nature of disease to recognize symptoms which indicate the fitness of this agency, too little of science in general to realize that a means suitable to remove one condition may be entirely inadequate or unsuitable to counteract another. Hardly a means of healing is known but had extravagant claims and prophecies made for it when it was first brought into use, which afterward settled down into a very moderate compass. Take, for instance, the transfusion of blood. The early transfusionists reasoned, in the style of the Christian Scientists, that the blood is the life. Take the bad blood out of a man and put new blood into him, and you draw off his diseases and infirmities and put new life into him. They even hoped to dispel insanity by this infusion of new life, and some went so far as to prophesy that moral infirmities would be cured in this way. The theory of Christian Science may seem very beautiful to persons of a highly religious and highly emotional nature, but it has no more connection with the cure of disease than a rainbow has with the multiplication table. It is a pretty fancy, and one hardly has the heart to dispel the illusion, but it is "as false as it is fair." Many of the most sanctimonious healers, who make the most impressive appeals to the piety of their victims, are in the business simply for the money they can get out of it. Others are honest, but are themselves deceived. It is fortunate that the patients of the Christian Scientists generally go back to the physicians when anything serious is the matter with them, or we should see a greater slaughter than has already occurred. About ninety-five per cent of the believers in this doctrine are women, and to their sensitive feelings the above may seem like ill-natured and hasty language. But it is neither. It is an earnest and deliberate effort to use the tests of science so as to show how unsubstantial is this rainbow-bridge upon which they are asked to trust their lives.

The Christian Science craze will have its day and then die out, like the blue-glass delusion and other crazes of like character. Already signs appear that it has reached its highest limit in the eastern part of the country, and that its decadence has begun. It is not occupying so much space as formerly in the newspapers; and it is becoming less profitable to those who practice it. A lady and her husband who set up a Christian Science school and hospital in New York recently found themselves a thousand dollars out at the end of the winter and gave up the business. In the West, however, where it appeared later, the movement still maintains considerable vigor.

It will have done good if it compels physicians to adopt mental healing, not as a panacea, but as an addition to the curative means now at their command, and for occasional intelligent use. This done, the sooner Christian Science, as a distinct mode of treatment, passes away, the better for all concerned. It is one more of those wonders of which Byron wrote:

> "Thus saith the preacher, 'Naught beneath the sun
> Is new,' yet still from change to change we run;
> What varied wonders tempt us as they pass!
> The cow-pox, tractors, galvanism, and gas
> In turns appear, to make the vulgar stare,
> Till the swollen bubble bursts—and all is air!"
>
> —*English Bards and Scotch Reviewers.*

ON THE CAUSES OF VARIATION.*

By C. V. RILEY, Ph. D., United States Entomologist.

II.—*Concluded.*

HAVING thus summarily indicated those factors of evolution associated with genesis and which are essentially physiological, however much psychical phenomena may co-operate, we may touch upon the more purely psychical factors or those pertaining to the growth and use of mind, employing the term to express those neural phenomena traceable to the medium of the brain. Their importance in evolution increases with increasing cephalization and complexity of nerve system. For the present purpose, however, it is with the objective side of psychology, or what may be called psycho-physiology, that we must deal.

Psychical—Use and Disuse.—Full consideration of the effect of use and disuse involves a discussion, not only of the question of the transmission of acquired structures, but of the influence of individual effort and of necessity—i. e., a consideration of the essentially Lamarckian factors in evolution. The occasion will not permit me to do full justice to these subjects. That functionally produced modifications are inherited was the great assumption upon which Lamarck founded his theory of evolution. Many able naturalists have insisted on it, and in my judgment there should no longer be any doubt whatever of the fact, not only so far as grosser structure is concerned, but brain-structure likewise. No question is of more moment in the whole range of biology, and especially biologic philosophy, and Spencer has well pointed out that on the answer to it will depend largely the sciences of psychology, ethics, and sociology. Weismann, Lankester, and others deny hereditary power in such modifications, the former believing that hereditary modification can result only from changes in the *germ plasma,* i. e., are virtually congenital. Natural selection, according to this view, plays upon the germ plasma; but I have

* From the address of the Vice-President of Section F of the American Association for the Advancement of Science, delivered at the Cleveland meeting, August, 1888.

never been quite able to comprehend how this view, even if established, militates against the transmissibility of acquired modification; for, whatever theory of heredity we adopt, it shows us rather the manner of the transmission, and therefore confirms its possibility. But the fact of such transmissibility rests neither on embryological nor theoretical grounds. It is a fact so fully demonstrated in the history of our domestic animals and the history of agriculture, that the skepticism of some of our great naturalists and embryologists must be attributed to that ignorance of the farmers' commonest experiences which is, unfortunately, a too frequent attribute of the city-trained investigator. Darwin in the beginning, and while the importance of natural selection was growing in his mind, allowed little importance to use and disuse, for the same reason that he subordinated external agencies; viz., that, in proportion as it acts on masses simultaneously, it must diminish the importance of natural selection. Yet he allowed more weight to it toward the end, and has furnished some of the best evidence drawn from domestic animals of the transmission of acquired characters affecting the dermal, muscular, osseous, and nervous systems. Spencer has shown that inheritance of functional modification is most easily observed and experimentally proved in those parts which admit of easy observation and comparison, as the dermal covering and the bones; and that they for the most part are beyond these tests in the muscular and nervous systems. Yet he logically concludes:

"Considering that unquestionably the modification of structure by function is a *vera causa*, in so far as concerns the individual; and considering the number of facts which so competent an observer as Mr. Darwin regarded as evidence that transmission of such modifications takes place in particular cases; the hypothesis that such transmission takes place in conformity with a general law, holding of all active structures, should, I think, be regarded as at least a good working hypothesis."

So far as entomology bears evidence, it confirms the fact that modifications of structure due to use or disuse on the part of the individual may be and are transmitted. These are easily observed in the exo-skeleton, and, while the experimental proof is yet limited, it is not wanting, especially in the history of apiculture. Excessive use of any organ will develop or enlarge it at the expense of other organs, just as disuse will cause a diminution or atrophy thereof. The variation in the individual will be within limits, but, when once the variation has set in, the tendency is always to an increased variation in the same direction in the descendants, especially if they continue the same use or disuse. Here, again, however, it is difficult to separate the modification due to individual effort, or want of effort, and the more general modification affecting the mass of individuals of a species through the environment; because the environment affects function, and function in its turn affects form and structure. The life of every individual furnishes an excellent illustration of new action and new uses for organs not previously used, in the striking and sudden employment of post-natal organs, both of respiration and nourishment, which pre-natally had no corresponding action. Romanes has argued that *cessation of selection* may reduce an organ where use or disuse can have no play, as in the loss of wings in neuter ants; and that by the law of compensation an organ may even be increased, as in the heads of such neuters. He enforces the idea by exampling the blind crabs of our Kentucky caves, where the complex eyes rapidly disappear under cessation of selection, but where the persistence of the foot-stalks indicates that economy of nutrition could have had little play! It is difficult, however, to draw the line between this cause and Lankester's reversal of natural selection; and still more difficult to say wherein either differs from mere disuse.

Degeneration, which has been urged as the true explanation of many of the existing forms of life, is, it seems to me, but a consequence of disuse, and would, therefore, fall into the present category, among causes of variation.

Emotion as affecting the Individual.—I have here considered the factor of use and disuse as a direct cause of variation, from the psychical rather than the physical standpoint—i. e., individual or conscious effort as furnishing food for natural selection, among more highly endowed animals, rather than as effort by species as a whole necessitated by physical conditions, and inducing modification in masses irrespective of selection. This leads us to the consideration of mind as a factor in evolution, and we shall soon see its importance as a fundamental cause of differentiation, among higher organisms at least. I am not sure, even, that its influence can be excluded from among lower animals, however much we may have to exclude its action in so far as plants are concerned; for any new functional effort inducing new use may be looked upon as conscious and intelligent as compared with use fixed by habit and lapsed into automatic action or instinct. The former typifies variability and progress; the latter constancy and stability.

Mind is a comprehensive cause of variation, and may be considered under several categories. We have, for instance, (1) the action of the mind of the individual in willing, or in selecting between differing alternatives that present themselves, as in the choice of means to ends; (2) the direct influence of the emotions on the individual; and (3) the influence of the emotions of the mother on her unborn offspring.

In the first category, the influence of mind in modifying is chiefly confined to man. It must have acted from the time when he first began to prepare his crude weapons of defense and offense to the present day, when some new discovery or some new invention may alter the map of the world, revolutionize society, or give one race or nation the advantage over another; nor can we feel sure that animals below man have not been modified by similar psychical effort. In the second category, the direct influence of the emotions on the individual, it is a psycho-physiological factor involved in the question of use and disuse; for if it be once admitted (and I think the tendency of modern neural science is in the direction of establishing the fact) that strong mental effort may be made to affect special parts of the body—i. e., that an excess of nervous force brought to play on any particular organ, or any particular part of the organism, induces increased growth or development of such parts; we can understand how far desire, especially under the spur of necessity, may be influential in inducing modification. Lamarck's idea, therefore, may not be so ridiculous as it has hitherto been supposed by many. Darwin took no stock in this influence, and referred with some contempt to the views of Lamarck and Geoffroy Saint-Hilaire. He thought it strange that the author of "Les Animaux sans Vertèbres" should have written that insects which never saw their eggs should will them to be of particular form, which he thought hardly less absurd than to believe that the desire to climb should make a pediculus formed to climb hair, or a woodpecker to climb trees.

Emotion of Mother as affecting Offspring.—There may be some doubt about the extent of the influence of the individual mind in inducing direct modification, for the subject is a difficult one to deal with, and we have few exact data to draw from. Since in human affairs we recognize the power of will in affecting purpose and action, and in molding character, it is legitimate to infer that when our knowledge has increased we shall recognize its effect on function. There can be less doubt as to the third category, viz., influence of the mind or emotions of the mother on her unborn offspring in inducing modification both physiological and mental. As a cause of variation, though believed in by J. D. Hooker, as we learn from the "Life and Letters," and by other of Darwin's contemporaries, it was discarded by Darwin himself, his principal reasons being that the results of observations made for him in hospitals were adverse to any such influence. Medical men, as a rule, also discard it as among the mere notions and superstitions of women, and argue its impossibility on the ground that there is no neural connection between mother and fœtus. The ancients practically recognized the influence of the imagination of the mother on her offspring, and belief in it is still very prevalent among women themselves, of all classes. Women alone are able to speak or feel in this matter from experience, and the almost universal belief in the influence, among those who have any experience at all, should make us hesitate to discard it too summarily. From facts within my own personal knowledge I have long believed in this influence, and the more I have been able to collect reliable data bearing upon it, the more confirmed have I become in the conclusion that the emotional experiences of the mother affect the issue in varying degree, according to the intensity of the emotion. When sudden and excessive, as in rage, fright, repugnance, etc., or where prolonged or accumulative, as in continued brooding, it may induce nervous disorders, and even mental aberration, idiocy, or insanity; or, again, physiological change, as atrophy or increase of parts, and other peculiarities which have relation to the form or character of the inducing mental manifestation or shock in the parent. Investigation of this, as of all subtle phenomena, is attended with the difficulty of separating the chaff of fancy from the grain of reality. The method pursued by Darwin is unsatisfactory, as it dealt with normal conditions which furnish no evidence and with the fanciful or notional side of the subject. The literature of the subject is extensive and quite interesting, and I would refer particularly to the work and writings of Viellard, Schönfeld, Demangeon, Lucas, Féré, and Brown-Séquard. Two other difficulties confront the investigator: first, the somewhat unsatisfactory state of neurology and the difficulty of experimental research therein, as indicated by Vice-President Bowditch before this section two years ago; secondly, the aversion, from feelings of delicacy, on the part of the persons concerned, to publicity of the more marked and striking evidence. The phenomena of hypnotism, proving as they do that physiological results may be induced through the imagination of the subject acted on by the mind of the hypnotizer, are suggestive in this connection, the work of Charcot in Paris more particularly showing how powerful the action may be, and how the effects of actual medicines may be produced by the use of imagined ones. The mind of the hypnotized under these conditions is brought into those exceptional and exalted conditions which are necessary in the case of the mother to produce on her offspring the effect which we are discussing. The recent experiments of Mr. C. T. Hodge on the effects of stimulation on the nucleus and cell-body and on protoplasm are also interesting here, showing, as they do, decrease in the two former and vacuolation of the latter as the result.

The history of science is present to tell us that common and persistent belief, based on experience, has not infrequently been met with skepticism and even ridicule on the part of scientific men, only to be vindicated finally by more thorough and exact knowledge. It is too often the case that, where the processes are recondite and difficult to follow, assumption passes for knowledge. The function of some of our own bodily organs yet remains to be established, and we probably assume too much in requiring that all nervous force must be transferred through nerve tissue, or that there may not be protoplasmic filaments which are not resolvable, in their finer ramifications, even with our best microscopes. The very nature of mind and its processes puts it beyond the reach of the scalpel of the anatomist or the physiologist, just as many psychical phenomena baffle the exact methods of science, at least those so far employed. Leaving out of the question the evidence of peculiar marks due to maternal emotion, cases of which are part of the unwritten history of almost every family, the striking cases of which I have authoritative evidence of addition to, subtraction from, or singular modification of, anatomical parts, confirm me in the belief that this is a most important psycho-physiological cause of modification.

In the romance of "Elsie Venner," in which the heroine's strange attributes are connected with pre-natal influence of the mother, who died of the bite of *Crotalus*, Oliver Wendell Holmes has strongly put forth this doctrine in the form of fiction. I allude to this clever romance because of the medical knowledge of the eminent author, and because, while admitting in the preface that a grave scientific doctrine lies beneath some of the delineations of character, he also affirms that he has had the most startling confirmation of its truth. The data collected on the subject I hope to bring together on some other more fit occasion; and I would take this opportunity of urging any in my hearing, or who may read these lines, if they have had or are aware of any authoritative and illustrative cases, to communicate them to me with as much detail as possible.

This theory once established, its bearing on evolution as a prime cause of variation must at once be manifest; for it gives not only tangibility to the Lamarckian idea of desire influencing modification, but also a conception of how Infinite Mind in nature may act through the finite in directing such modification. No doubt but that there is a great deal of nonsense and superstition mixed with the genuine, and that the idea that every little whim, or fancy, or imagining of the mother will produce record or mark is one of the unjustified outcroppings of the fundamental fact, and helps to explain the difficulty of getting at the real facts and the ease with which Darwin rejected the idea. In my judgment, this factor acts only when, from whatever cause, and particularly under the spur of necessity, the emotions are exceptionally intensified, or the desire strongly centered in some particular object. The conception is perfectly legitimate, for instance, that when a species is subjected to any external modifying cause, affecting all its members alike, the adaptive modifications which natural selection, under such circumstances, would play upon, have their origin in the emotions, or the influences at work on the pregnant females, giving direction in their offspring, to the needed changes. In this way it is probable that only those individuals born under such conditions would be able to survive. Thus this becomes no mere ancillary cause of variation, but one of deepest import and at the very foundation of evolution. The female in this light acquires an increased importance, and evolution finds her not only the essential at the dawn of life upon our planet, but, in its present highest manifestations, she is nearest by instinct, intuition, and aspiration to the Controlling Mind which in the beginning quickened the great womb of Nature and down through all the ages guided the continuous stream of life to designed ends through the womb of the individual mother.

As already remarked, the psychical factors which we have been considering are substantially Lamarckian, and in proportion as we consider them and get to understand the other direct causes of variation, must we give importance to the ideas of Lamarck and, conversely, less importance to the ideas of Darwin.

Did time permit, I should like to go into an analysis of Lamarck's "Philosophie zoologique," and show how the genius of this illustrious French naturalist anticipated a very large part of that which Darwin subsequently so laboriously helped to establish. I must pass the subject, however, and simply record my surprise that one who was otherwise so honest and fair toward other writers, was so evidently unfair in his estimate of the work of Lamarck, as Darwin, in the "Life and Letters," is shown to have been. It is incomprehensible, reading Lamarck with our present knowledge, that Darwin should have found neither fact nor ideas in a book which abounds in both, except on the theory of a poor translation or that strange national antipathy which has so often prevented the people of one country from doing justice to those of the other, and which so long prejudiced the French Academy against Darwin's own especial theories.

Darwinism assumes essential ignorance of the causes of variation, and is based on the inherent tendency thereto in the offspring. Lamarckism, on the contrary, recognizes in use and disuse, desire and the physical environment, immediate causes of variation affecting the individual and transmitted to the offspring, in which it may be intensified again both by inheritance and further individual modification. Both represent important principles in evolution and co-operate to bring about the results. The theory I propose gives renewed importance to the Lamarckian factors by showing one manner of their action not previously urged, and it also helps us to a tangible and scientific conception of design.

Acceleration and Retardation.—In this rapid glance at the immediate causes of variation we have discussed some factors which in some degree represent laws rather than inducing causes of variation. This difficulty appertains to all attempts at formulation of the causes of variation, and only as our actual knowledge increases shall we be able succinctly and definitely to classify the factors. There are, however, certain important laws which have influenced modification but in no sense can be looked upon as causes of variation. They are laws or principles of evolution, by which we may account for the formation of types, acting, just as natural selection does, in differentiating rather than in originating the variation. No one can have followed the important and suggestive works of Cope and Hyatt on the subject of acceleration and retardation and not feel that it expresses an important law of this kind. It is, as I understand it, a factor in evolution not comparable with the principle of natural selection, but complementary thereto, much in the same way as physiological selection and sexual selection are. It is an attempt to give expression and form to a set of facts to which palæontology undoubtedly points and which ontogeny substantiates, viz., that certain types may attain perfection in time and then retrogress and finally become extinct, and that existing types which are dying out, or degenerating, exhibit, ontogenically, the culmination of force and complexity, followed by decadence, corresponding to the phylogenic history of the type. We know from the "Life and Letters" that Darwin gave up in despair the attempt to grasp the full meaning of these particular views of our associates, and, in a letter to Hyatt, with characteristic modesty, he attributes this inability to his own dullness rather than to any weakness in the theory. Others have experienced the same difficulty, and believe, with Prof. Morse, that the facts enumerated, as well as the facts of exact and inexact parallelism, are explicable on the doctrine of natural selection. This is true, it seems to me, only on the broader, unjustified interpretation of the doctrine to which I have previously alluded in the opening of these remarks. The law of acceleration and retardation may, perhaps, be substantially stated in this wise: that certain groups acquire some characters rapidly, while corresponding groups acquire the same characters more slowly, or never acquire them at all; and this brings us to another important factor of evolution which serves to give force to the law.

Acceleration by Primogeniture.—This has been elaborated by Hubrecht. He argues that so long as the parent form remained most in harmony with the surrounding conditions, it would maintain in the struggle for existence its characteristics against all tendency to vary in its offspring, which is equivalent to saying that it will remain unchanged so long as the environment remains the same. He then shows that in organisms in which the reproductive period covers many years, accelerated development by primogeniture, i. e., as between the first born and the last born of any pair and of their posterity, will, in time, produce differentiation. The series of the first born will, in the course of time, involve many generations at short distances from each other, whereas the series of the last born will, on the contrary, consist of a much smaller number of terms, each separated from its predecessor by a more considerable distance. Any tendency to variation from external or internal influences must needs find more numerous occasions to act in the series of the first born, not only because these have a more composite ancestry, but because they necessarily become the most numerous. In other words, the chances are more numerous for small differences among the first-born series, and, in proportion as such differences are accumulated, intercrossing with the series of the last born will become rarer. This law will gain from physiological selection, and, it seems to me, throws additional light on that of acceleration and retardation. It must act more particularly among higher animals, where the reproductive period is lengthened, and the time between the first and last born is great.

Saltation.—We are thus led to what have been called saltations in evolution. Although the history of palæontology has continually added to our knowledge of past forms, and helped to fill up many gaps in the evolutional series, and although during the last quarter of a century it has particularly vindicated Darwin's prophecy that many links would yet be found, the substantial truth remains that gaps still occur, and that progress, so far as present knowledge indicates, has been made by occasional saltations. There have been, it would seem, periods of rapid movement, and of comparative repose or readjustment of equilibrium. Cope concludes that "genera and higher categories have appeared in geologic history by more or less abrupt transitions or *expression-points*, rather than by uniform gradual successions."

One of Pictet's strongest points in opposition to Darwin's theory, which struck Darwin himself with much force, was that it ill agreed with the history of organisms with well marked and defined forms, which seem to have existed during but a limited period, as, for instance, the flying reptiles, the ichthyosaurus, belemnites, ammonites, etc. Some authors, who have fully recognized these gaps or leaps in the developmental history of animals, yet believe them to be consistent with the theory of gradual modification. It may be only one individual of many which becomes modified and transmits the modification to descendants; it may be but one species of a genus which, for similar reasons, supersedes the rest which become extinct in time proportioned to prolificacy.

There is no reason to suppose that the history of organic life has differed in this respect from that of inorganic. We need not discuss here the question of catastrophism and uniformitarianism in geology However much the latter prevails at the present time, both have doubtless operated in the past. Catastrophism would necessarily produce gaps, or saltations, in the palæontological record, as only the more plastic species would adapt themselves and survive under its influence. It is not gaps due to such causes that are here to be considered, however, but those which occur in uniform strata. Haldeman has most suggestively remarked that the same mineral will crystallize with three, six, or twelve angles, but not with five or seven, and he asks, Are the facts of organic morphism subject to less definite laws? Cope has drawn another illustration from inorganic forces, in the three great changes in water, from solid, liquid, and vapor, which take place suddenly at what may be called two *expression-points* of the thermometer, the many intervening degrees involving no change. Rhythm or wave movement would seem to be a universal attribute of matter, whether organic or inorganic. The forces of nature are constant, but the phenomena induced are often paroxysmal. The progressive forces accumulate, while the conservative forces resist, until at last resistance gives way with comparative suddenness. There is every reason to believe that the life-movement, in its ascending complexity, has shared this common law. Accumulation is proportioned to the change in environment, and resistance to the age or rigidity of the organism. The latter may be strong enough to end in death or extinction, or it may break down, and, with comparatively sudden yielding and conformity to necessity, burst the confines and begin a new series of variations and adaptations. In either case we have breaks, because the dying or dropping out of one type makes room for another more accommodating. Rapid evolution, from causes already discussed, implies gaps which must be marked according as the strength of the conservative forces and the violence of the final accommodation are great, and because certain breaks are more apt to occur after long periods of stability. The break may be induced by changes in physical environment or without such change; if the latter, it will more likely occur in some individual born with a marked departure from the type that gives it some advantage, and whose issue will in time supplant all other individuals. In either case we shall have, palæontologically, distinct species or genera, one superposed on the other, without links.

To the imperfection of the geologic record is to be attributed, no doubt, a large number of these gaps yet existing between types, and many important links or branches are yet to be discovered. Yet the views we have been considering should absolve evolutionists from all necessity of demonstrating the more minute gradations; because, in deposits like the Tertiary, during which we may assume life-conditions to have remained comparatively uniform, these saltations take place. Saltation, or, what is probably a truer expression, wave-movement, would indeed seem to be a prerequisite of progress, and will account for much that is going on even at the present day. In artificial selection by man we find that it is at first comparatively easy to accumulate minute peculiarities and variations by rigid breeding and exclusion of all deviation; but that we soon arrive at a fixed point which is maintained at first with difficulty but with increasing ease with each generation. During these more fixed periods the potentiality for change is doubtless increasing, until at last it is suddenly manifested in renewed variation. Rest is followed by activity just as surely as activity induces and requires rest.

There is a limit to development in organs, just as there is a limit to individual mental growth. Weariness of previous effort comes upon us when the limit of result is attained, accompanied by great longing for change, and not infrequently with revulsion from previous effort. The naturalist who has devoted a part of his life to the persistent accumulation of facts and specimens, has held the imaginative and generalizing powers in abeyance during that period. The reserve brain-force in this direction may be suddenly called into activity by exhaustion in the other, and the process may perhaps be comparable to the exhaustion of the soil for one particular crop, without lessening its fertility for some other, the recognition of which fact is the foundation of all successful agriculture. Excess of development, whether in body or mind, inevitably brings about either wholesome reaction or utter collapse.

How far the rhythmic tendency in the development of animal life may be explained by the rapid change of climate, by migration and the loss of record, or upon the general law that while there has been progress of the whole, there has not necessarily been progress of every part, it would take us too far to discuss in this connection. I think we are safe in saying, however, that the facts justify the belief that, in the evolution of animal life, as in the evolution of everything else, progress has often been made by waves.

Fiske's Law.—With regard to what may be called Fiske's law of correlation between brain development and infantile dependency, Fiske has so admirably elaborated the subject that it needs no further elucidation here as the principal factor in the evolution in man, first of the family relation, then of the clan, the tribe, and the nation. With this factor in mind, and the immense superiority which anthropoid man must have had, when brain development had once induced this fundamental community of interest over the rest of brute creation, the gap between primitive man and the higher anthropoid apes in the past, or between the present lower races of man and the higher existing primates, is easily explained, even if it had not been greatly exaggerated. At the present time we may note and record the further inevitable increase in the gap, for the lower races of man are gradually becoming extinct, and the higher apes can not long hold their own or persist.

Brooks's Hypothesis.—I have already alluded to Brooks's hypothesis under the head of sexual differentiation, and his work on heredity must be so familiar to you that his views need but a passing notice. He believes that sex differentiation means fundamentally a physiological division of labor, and that the male is essentially the progressive or diversifying and the female the conservative agent. As organisms gradually increased in size, as the number of cells in their bodies became greater, and as the differentiation and specialization of these cells became more and more marked, one element, the male cell, became adapted for storing up gemmules, and, at the same time, gradually lost its unnecessary and useless power to transmit hereditary characteristics.

The theory finds support in some of the phenomena of life, and doubtless expresses a law not easily established, for which reason it will not be readily accepted. It leaves entirely out of consideration some of the forces at work which I have already indicated, and in so far must be considered only a law of secondary importance. However much we may admit the general truth that the germ-cell continues the past and the sperm-cell tends to diverge from it, as a purely dynamic proposition, inducing variation for natural selection to play upon, it does not in any way decrease the overwhelming importance of the female in inducing, through psychico-physiological influences, a needed and purposeful modification in the manner which I have already expounded.

The probable character of the language of palæolithic man is the subject of one of Dr. Brinton's latest studies. Taking some very primitive American languages as his guide, he concludes that it was more rudimentary than any language known to us; that it had no grammatical form or fixed phonetic values, but depended largely upon gesture, tone, and stress; that its words often had antithetic meanings, which could only be determined from the accent or sign; and that the different vowel-sounds and consonantal groups conveyed specific significance, and were of more import than the syllables which they formed.

CURIOSITIES OF NATURAL GAS.

By Prof. JOSEPH F. JAMES, M. S.

IT is but little more than four years since there appeared, among the economical products of Ohio and Indiana, a new force, which has worked a sort of revolution among manufactures. The geographies used to say Ohio was noted for wheat, corn, and pork; now they must add petroleum and natural gas.

Rock-oil, or petroleum, has long been known to the world at large. So, too, has natural gas. The former was the early pioneer's panacea. So precious was it that it was soaked up from the ground by blankets, and was then wrung out and preserved for times of need. The latter was and is still dreaded by miners as the deadly "fire-damp." It was known to the Chinese long years ago, and wells three thousand feet deep, giving off great volumes of the material, were not uncommon. Burning springs had been found in Virginia in 1775, and were well known in the valley of the Kanawha River in the early part of this century. Fredonia, in New York State, was lighted by natural gas in 1824; while immense quantities of the precious fuel were at a later period, and before its great value had become recognized, wasted in the oil regions of Pennsylvania.

Notwithstanding these facts, no one suspected that there lay, concealed a thousand feet deep in the soil of Ohio and Indiana, such a wonderful source of power as has been discovered. Those who first sought for it were designated by the usual and familiar appellations of fools and cranks, just as the originators of the telephone, the telegraph, the locomotive, and the steam-engine had been before them. Recent events have proved the wisdom of the pioneers in the new field, and now portions of Ohio and Indiana are famous the world over as reservoirs of that wonderful product of Nature's laboratory, natural gas.

The excitement which followed the announcement of the discovery of natural gas at Findlay, Ohio, was like that following the discovery of gold in California—with this exception, that whereas the gold-fields were to be sought for in a far-away country, the gas was to be had at our very doors. The earth had but to be penetrated a few hundred or a thousand feet, and there was the equivalent of a gold-mine; at least, so it was imagined, and, with this idea firmly implanted, every little town within a radius of a hundred miles of Findlay, and even further away, determined to have some of the precious fuel. Experience has demonstrated that the thing can not be had for the asking in every locality. It has been shown that only where certain conditions of the rocky strata of the earth exist, is the gas likely to be present in any quantity; and that outside of where these conditions obtain it is useless to expend money in sinking wells.

The busy operations thus inaugurated were watched by scientific men with great interest. A new horizon for the gas was the point which especially attracted their attention, for the fuel came from a stratum far below those belts which had in Pennsylvania and Virginia produced the gas and oil. Besides, to the geologist was promised an opportunity of increasing his knowledge of the arrangement of certain strata beneath the surface, whose course *at* the surface had long been known. The geologist knew that, even when the attempt to secure gas was unavailing there was a possibility of the dry well revealing to him a new chapter in the story of the rocks.

The practical man, for his part, looked upon the new fuel with an eye to its utilization. By lessening the cost of production, it increased his profits, if indeed increased competition did not keep the price down in proportion. A dry well was to these men a calamity, for it brought them in nothing for their outlay.

With a third class the new fever opened up a field of speculation, of which they were not slow to avail themselves. Theorists are ever ready to thrust upon a patient world their views, even though the chances of formulating a correct theory are small. The origin of the gas has, therefore, formed a fruitful source of speculation with these persons. Some of the causes assigned are so supremely ridiculous as to deserve notice as psychological curiosities. Two or three of these crude theories will occupy but a few moments.

One writer asks whether it is safe to bore the earth too much. He assumes the earth to be a hollow sphere filled with a gaseous substance called by us natural gas, and he thinks that tapping these reservoirs will cause disastrous explosions, resulting from the lighted gas coming in contact with that which is escaping. Earthquakes, he says, are probably caused by vacuums created by the outflowing gas. He compares the earth to a balloon floated and kept distended by the gas in the interior, which, if exhausted, will cause the crust to collapse, affect the motion of the earth in its orbit, cause it to lose its place among the heavenly bodies, and fall in pieces. He thinks man is too inquisitive; he wants to peer into the earth too far. But let him beware. Children should not be allowed to handle explosives, nor should ignorant man meddle with natural gas. "Let the matter be fully investigated by able, God-fearing men—men who believe in the Bible as well as geology"—and all may yet be well.

Another writer thinks that boring should be prohibited by stringent laws. He, too, thinks there is a possibility of an explosion, though from another cause. For, did not the same craze possess China two centuries ago? Were not wells bored in great numbers, and was not the escaping gas ignited? So much so, indeed, that finally one huge well sucked down the fiery volume of a smaller one into its own aperture, and a violent explosion ensued which destroyed thousands of people. A similar catastrophe he considers imminent in Ohio and Indiana. Should such a disaster occur, "the country along the gas-belt from Toledo through Ohio, Indiana, and Kentucky will be ripped up to the depth of twelve or fifteen hundred feet, and flopped over like a pancake, leaving a chasm through which the waters of Lake Erie will come howling down, filling the Ohio and Mississippi Valleys, and blotting them out forever"! Prompt action should be taken. The Governor should call a special session of the Legislature, and the President a special session of Congress, to enact laws to protect the nation against "destruction from natural gas."

Another, called an experienced miner, gone wild over his ignorance in regard to the Trenton limestone—words in everybody's mouth—says that probably the "so-called Trenton limestone is nothing but an incident found about already successful gas-wells. It probably came out of the rift the same as other materials. It is found in the Colorado mines, and is called by the miners bastard quartz"! Such geological knowledge requires no comment.

Still another theorist has investigated the gas-wells with telephones and delicate thermometers, and he announces startling discoveries. He distinguished sounds like the boiling of rocks, and estimated that a mile and a half or so beneath Findlay the temperature of the earth is 3,500°. This scientist says an immense cavity exists under Findlay, and that here the gas is stored; that a mile below the bottom of the cavity is a mass of roaring, seething flame, which is gradually eating into the rocky floor of the cavern and thinning it. Eventually the flames will reach the gas, a terrific explosion will ensue, and Findlay and its neighborhood will be blown skyward in an instant. Such are some of the theories gravely propounded in respect to this new fuel. The effects of the *use* of the fuel are almost as wonderful as the theories of its origin.

In the year 1884 the town of Findlay, Ohio, had a population of about 4,500. In the spring of that year Dr. Charles Oesterlin, who had for years been a firm believer in the existence of quantities of natural gas in and about the town, induced some friends to join him in forming a stock-company to bore for gas. Work was not begun until near the end of October, but in the course of time a well was sunk to a depth of 1,092 feet. At this depth a reservoir of gas was tapped, the like of which had not been dreamed of before. A new era had opened for Findlay. The blaze from the lighted stand-pipe shot up twenty or thirty feet in the air. The light could be seen twenty-five or thirty miles away in all directions. The amount of gas given off daily was estimated at about 250,000 cubic feet. People flocked from far and near to see the wonderful sight. Other wells were, of course, immediately begun, the most of them being successful. In December, 1885, the largest well of the field was drilled in, and from a depth of 1,144 feet came the gas of the great Karg well. The roar of this could be heard two or three miles, while its light was visible thirty-five or forty miles on all sides. Its flow was estimated at over 12,000,000 cubic feet per day. It has proved to be Findlay's standing advertisement, and it has been a sign which says to many, "Natural gas has come to stay."

The town began to grow as soon as the first well had proved a success. From 4,500, in 1884, it had grown to 6,000 in January, 1886. In the spring of 1887 a speculative fever broke out, which affected the whole State. From a town originally four square miles in extent, Findlay has grown to twenty-four square miles area. From a population of 6,000, in 1886, it had grown to 10,000 in the spring of 1887. In September of the same year the population was estimated at from 13,000 to 18,000, and at that time it was calculated its people would number 30,000 in the early part of 1888. The value of real estate rose rapidly; two, three, even five times its previous value was given for land. Farms which had been held at $100 per acre changed hands at $300 per acre and over. These acres were divided into lots, and greedily bought by speculators at so much per foot. Real estate to the value of over $300,000 has changed hands in a single day.

This speculative fever caused a wonderful activity while it lasted. The offer of plots of ground and of free gas brought an influx of manufactories of all kinds. Seven hundred houses were built during the first half of 1887, and as many more were under contract to be finished before the end of the year. Glass-factories, rolling-mills, iron and steel works, furniture-factories, brick-yards, lime-kilns, and many other branches of trade, have been successfully established. The gas company, which had previously to the new discovery supplied the town with artificial gas, secured numerous wells of their own, among them the Karg well, and established a new scale of prices. But the citizens complained about the rates, succeeded in inducing the Legislature to allow them to issue bonds for $60,000 to supply their own gas, and soon so reduced the price that the gas company sold out to the city. The rates had then been cut to only fifteen cents a month for either a cooking or a heating stove; it is now stated to be furnished free of cost to the citizens (*vide* circular of the Chamber of Commerce).

No sooner had Findlay added natural gas to her attractive features than every town in the vicinity determined to seek for the fuel. The soil of Ohio and Indiana has been bored full of holes in this search. Many places have been successful, more have failed; for, as Dr. Orton says: * "Every county in the western half of Ohio, without exception, has already drilled one or more wells to the Trenton limestone, or at least has made a vigorous and determined effort to reach the new source of light and heat. Many counties outside this limit have spent and are still spending money lavishly in the same search. Even small villages, that have heretofore counted themselves too poor to provide such fundamental requirements of comfortable living as sidewalks, street-lamps, and graveled roadways, find no trouble in raising money enough to drill two thousand feet, or more, into the underlying rocks, in search for natural gas. When such towns attain any pronounced success in their drilling, they are sometimes temporarily embarrassed thereby, as there are, in many cases, no industries established in them to which a large flow of gas can be profitably applied."

The amount of gas given off from the numerous successful wells in the new fields in Ohio and Indiana is incredible. Findlay itself is estimated to possess a supply of 60,000,000 cubic feet per day. Bowling Green has several wells which yield over 900,000 cubic feet per day. Muncie, Indiana, with seven wells, is calculated to have 6,000,000 cubic feet a day. Noblesville has one well yielding about 2,000,000 cubic feet, and so on for a long list. Probably at least 100,000,000 cubic feet a day would be the yield of the wells which are now productive in this territory.

Where all this is occurring, it is a matter of vital importance to ascertain whether the supply will be a lasting one. There is little doubt but that it is a stored force, and, when once exhausted, as it must rapidly be, there will be no new supply. Yet the waste which goes on is simply appalling. Some of the wells burned for months before they were controlled or utilized. Almost every new well, wherever found, is lighted and allowed to burn at the rate of from 200,000 to 2,000,000 cubic feet per day, often for weeks. It is stated † that for several months of 1886 no less than 18,000,000 cubic feet of gas were burned in or about Findlay every day. The Karg well alone, it is estimated, caused a loss to the field of 150,000,000 cubic feet of this precious fuel. Now, it is true, there is less of this wanton waste going on. Owners of wells and others who are interested have come to see the importance

* "Ohio Geology," vol. vi, p. 117. † Ibid., p. 133.

of husbanding this valuable product, and there is less and less waste every day. Indeed, it behooves all to be careful, for, with the exhaustion of the gas, the improvements, the factories, the towns themselves will vanish.

PLANTS IN WITCHCRAFT.*

By T. F. THISELTON DYER.

THE vast proportions which the great witchcraft movement assumed in by-gone years explains the magic properties which we find ascribed to so many plants in most countries. In the nefarious trade carried on by the representatives of this cruel system of sorcery certain plants were largely employed for working marvels, hence the mystic character which they have ever since retained. It was necessary, however, that these should be plucked at certain phases of the moon or seasons of the year, or from some spot where the sun was supposed not to have shone on it.† Hence Shakespeare makes one of his witches speak of "root of hemlock digg'd i' the dark," and of "slips of yew sliver'd in the moon's eclipse," a practice which was long kept up. The plants, too, which formed the witches' pharmacopœia, were generally selected either from their legendary associations or by reason of their poisonous and soporific qualities. Thus, two of those most frequently used as ingredients in the mystic caldron were the vervain and the rue, these plants having been specially credited with supernatural virtues. The former probably derived its notoriety from the fact of its being sacred to Thor, an honor which marked it out, like other lightning plants, as peculiarly adapted for occult uses. It was, moreover, among the sacred plants of the Druids, and was only gathered by them, "when the dog-star arose, from unsunned spots." At the same time, it is noteworthy that many of the plants which were in repute with witches for working their marvels were reckoned as counter-charms, a fact which is not surprising, as materials used by wizards and others for magical purposes have generally been regarded as equally efficacious if employed against their charms and spells.‡ Although vervain, therefore, as the "enchanters' plant," was gathered by witches to do mischief in their incantations, yet, as Aubrey says, it "hinders witches from their will," a circumstance to which Drayton further refers when he speaks of the vervain as "'gainst witchcraft much avayling." Rue, likewise, which entered so largely into magic rites, was once much in request as an antidote against such prac-

* From "The Folk-Lore of Plants," in the press of D. Appleton & Co.

† See Moncure Conway's "Demonology and Devil-Lore," 1880, ii, 324.

‡ See Friend's "Flower-Lore," ii, 529, 530.

tices; and nowadays, when worn on the person in conjunction with agrimony, maiden-hair, broom-straw, and ground-ivy, it is said in the Tyrol to confer fine vision, and to point out the presence of witches.

It is still an undecided question as to why rue should out of all other plants have gained its wide-spread reputation with witches, but M. Maury supposes that it was on account of its being a narcotic and causing hallucinations. At any rate, it seems to have acquired at an early period in England a superstitious reverence, for, as Mr. Conway says,* "we find the missionaries sprinkling holy water from brushes made of it, whence it was called 'herb of grace.'"

Respecting the rendezvous of witches, it may be noted that they very frequently resorted to hills and mountains, their meetings taking place "on the mead, on the oak sward, under the lime, under the oak, at the pear-tree." Thus the fairy rings which are often to be met with on the Sussex downs are known as hag-tracks,† from the belief that "they are caused by hags and witches, who dance there at midnight."‡ Their love for sequestered and romantic localities is widely illustrated on the Continent, instances of which have been collected together by Grimm, who remarks how "the fame of particular witch-mountains extends over wide kingdoms." According to a tradition current in Friesland,# "no woman is to be found at home on a Friday, because on that day they hold their meetings and have dances on a barren heath." Occasionally, too, they show a strong predilection for certain trees, to approach which as night-time draws near is considered highly dangerous. The Judas-tree (*Cercis siliquastrum*) was one of their favorite retreats, perhaps on account of its traditionary association with the apostle. The Neapolitan witches held their tryst under a walnut-tree near Benevento,‖ and at Bologna the peasantry tell how these evil workers hold a midnight meeting beneath the walnut-trees on St. John's Eve. The elder-tree is another haunt under whose branches witches are fond of lurking, and on this account caution must be taken not to tamper with it after dark.^ Again, in the Netherlands, experienced shepherds are careful not to let their flocks feed after sunset, for there are wicked elves that prepare poison in certain plants—nightwort being one of these. Nor does any man dare to sleep in a meadow or pasture after sunset, for, as the shepherds say, he would have everything to fear.

* "Demonology and Devil-Lore," ii, 324.

† Grimm, "Teutonic Mythology," 1883, iii, 1051.

‡ Folkard's "Plant Lore, Legends, and Lyrics," 1884, p. 91.

\# Thorpe's "Northern Mythology," iii, 19.

‖ Grimm's "Teutonic Mythology," iii, 1052.

^ See Thorpe's "Northern Mythology," iii, 267.

A Tyrolese legend* relates how a boy who had climbed a tree "overlooked the ghastly doings of certain witches beneath its boughs. They tore in pieces the corpse of a woman, and threw the portions in the air. The boy caught one, and kept it by him; but the witches, on counting the pieces, found that one was missing, and so replaced it by a scrap of alder-wood, when instantly the dead came to life again."

Similarly, also, they had their favorite flowers, one having been the foxglove, nicknamed "witches' bells," from their decorating their fingers with its blossoms; while in some localities the harebell is designated the "witches' thimble." On the other hand, flowers of a yellow or greenish hue were distasteful to them.†

In the witchcraft movement it would seem that certain plants were in requisition for particular purposes, these workers of darkness having utilized the properties of herbs to special ends. A plant was not indiscriminately selected, but on account of possessing some virtue as to render it suitable for any design that the witches might have in view. Considering, too, how multitudinous and varied were their actions, they had constant need of applying to the vegetable world for materials with which to carry out their plans. But foremost among their requirements was the power of locomotion wherewith to enable them, with supernatural rapidity, to travel from one locality to another. Accordingly, one of their most favorite vehicles was a besom or broom, an implement which, it has been suggested, from its being a type of the winds, is an appropriate utensil "in the hands of the witches, who are wind-makers and workers in that element."‡ According to the "Asiatic Register" for 1801, the Eastern as well as the European witches "practice their spells by dancing at midnight, and the principal instrument they use on such occasions is a broom." Hence, in Hamburg, sailors, after long toiling against a contrary wind, on meeting another ship sailing in an opposite direction, throw an old broom before the vessel, believing thereby to reverse the wind.# As, too, in the case of vervain and rue, the besom, although dearly loved by witches, is still extensively used as a counter-charm against their machinations—it being a well-known belief both in England and Germany that no individual of this stamp can step over a besom laid inside the threshold. Hence, also, in Westphalia, at Shrovetide, white besoms with white handles are tied to the cows' horns; and, in the rites connected with the midsummer fires kept up in different parts of the country, the besom holds a prominent place. In Bo-

* See Folkard's "Plant Lore, Legends, and Lyrics," p. 209. † Ibid., p. 104.

‡ See Kelly's "Indo-European Folk-Lore," pp. 225–227.

See Hardwick's "Traditions, Superstitions, and Folk-Lore," p. 117; also Grimm's "Teutonic Mythology," 1883, iii, 1083.

hemia, for instance, the young men collect for some weeks beforehand as many worn-out brooms as they can lay their hands on. These, after dipping in tar, they light—running with them from one bonfire to another—and when burned out they are placed in the fields as charms against blight.* The large ragwort—known in Ireland as the "fairies' horse"—has long been sought for by witches when taking their midnight journeys. Burns, in his "Address to the Deil," makes his witches "skim the muirs and dizzy crags" on "rag-bred nags" with "wicked speed." The same legendary belief prevails in Cornwall, in connection with the Castle Peak, a high rock to the south of the Logan stone. Here, writes Mr. Hunt,† "many a man and woman too, now quietly sleeping in the churchyard of St. Levan, would, had they the power, attest to have seen the witches flying into the Castle Peak on moonlight nights, mounted on the stems of the ragwort." Among other plants used for a similar purpose were the bulrush and reed, in connection with which may be quoted the Irish tale of the rushes and cornstalks that "turn into horses the moment you bestride them."‡ In Germany# witches were said to use hay for transporting themselves through the air.

When engaged in their various occupations they often considered it expedient to escape detection by assuming invisibility, and for this object sought the assistance of certain plants, such as the fern-seed. In Sweden, hazel-nuts were supposed to have the power of making invisible, and it may be remembered how, in one of Andersen's stories, the elfin princess has the faculty of vanishing at will by putting a wand in her mouth.‖ But these were not the only plants supposed to confer invisibility, for German folk-lore tells us how the far-famed luck-flower was endowed with the same wonderful property; and by the ancients the heliotrope was credited with a similar virtue, but which Boccaccio, in his humorous tale of Calandrino in the "Decameron," applies to the so-called stone: "Heliotrope is a stone of such extraordinary virtue that the bearer of it is effectually concealed from the sight of all present." Dante, in his "Inferno," xxiv, 92, further alludes to it:

> "Amid this dread exuberance of woe
> Ran naked spirits winged with horrid fear,
> Nor hope had they of crevice where to hide,
> Or heliotrope to charm them out of view."

In the same way, the agate was said to render a person in-

* See Thorpe's "Northern Mythology," 1852, iii, 21, 137.
† "Popular Romances of the West of England," 1871, p. 330.
‡ Grimm's "Teutonic Mythology," iii, 1084.
# See Thorpe's "Northern Mythology," iii, 208, 209.
‖ See Yardley's "Supernatural in Romantic Fiction," 1880, pp. 131, 132.

visible, and to turn the swords of foes against themselves.* The Swiss peasants affirm that the Ascension-Day wreaths of the amaranth make the wearer invisible, and in the Tyrol the mistletoe is credited with this property.

But some plants, as we have already pointed out, were credited with the magic property of revealing the presence of witches, and of exposing them engaged in the pursuit of plying their nefarious calling. In this respect the St. John's wort was in great request, and hence it was extensively worn as an amulet, especially in Germany on St. John's Eve, a time when not only witches by common report peopled the air, but evil spirits wandered about on no friendly errand. Thus the Italian name of "devil-chaser," from the circumstance of its scaring away the workers of darkness, by bringing their hidden deeds to light. This, moreover, accounts for the custom so prevalent in most European countries of decorating doorways and windows with its blossoms on St. John's Eve.

But, in spite of plants of this kind, witches somehow or other contrived to escape detection by the employment of the most subtle charms and spells. They generally, too, took the precaution of avoiding such plants as were antagonistic to them, displaying a cunning ingenuity in most of their designs which it was by no means easy to forestall. Hence in the composition of their philters and potions they infused the juices of the most deadly herbs, such as that of the nightshade or monk's-hood; and to add to the potency of these baleful draughts they considered it necessary to add as many as seven or nine of the most poisonous plants they could obtain, such, for instance, as those enumerated by one of the witches in Ben Jonson's "Masque of Queens," who says:

"And I ha' been plucking plants among
Hemlock, henbane, adder's tongue;
Nightshade, moonwort, libbard's bane,
And twice, by the dogs, was like to be ta'en."

Another plant used by witches in their incantations was the sea or horned poppy, known in mediæval times as *Ficus infernalis;* hence it is further noticed by Ben Jonson in the "Witches' Song":

"Yes, I have brought to help our vows,
Horned poppy, cypress-boughs,
The fig-tree wild that grows on tombs,
And juice that from the larch-tree comes."

Then, of course, there was the wondrous moonwort (*Botrychium lunaria*), which was doubly valuable from its mystic virtue, for,

* See Fiske, "Myths and Mythmakers," p. 44; also Baring-Gould's "Curious Myths of the Middle Ages," 1877, p. 398.

as Culpepper* tells us, it was believed to open locks and possess other magic virtues. The mullein, popularly termed the hag-taper, was also in request, and the honesty (*Lunaria biennis*), "in sorceries excelling," was equally employed. By Scotch witches the woodbine was a favorite plant,† who, in effecting magical cures, passed their patients nine times through a girth or garland of green woodbine.

Again, a popular means employed by witches of injuring their enemies was by the bryony. Coles, in his "Art of Simpling," for instance, informs us how "they take likewise the roots of mandrake, according to some, or, as I rather suppose, the roots of briony, which simple folk take for the true mandrake, and make thereof an ugly image, by which they represent the person on whom they intend to exercise their witchcraft." And Lord Bacon, speaking of the mandrake, says: "Some plants there are, but rare, that have a mossie or downy root, and likewise that have a number of threads, like beards, as mandrakes, whereof witches and impostours make an ugly image, giving it the form of a face at the top of the root, and leave those strings to make a broad beard down to the foot." The witchcraft literature of the sixteenth and seventeenth centuries contains numerous allusions to the diabolical practice—a superstition immortalized by Shakespeare. The mandrake, from its supposed mysterious character, was intimately associated with witches, and Ben Jonson, in his "Masque of Queens," makes one of the hags who has been gathering this plant say:

> "I last night lay all alone
> On the ground, to hear the mandrake groan;
> And plucked him up, though he grew full low,
> And, as I had done, the cock did crow."

We have already incidentally spoken of the vervain, St. John's wort, elder, and rue as antagonistic to witchcraft, but to these may be added many other well-known plants, such as the juniper, mistletoe, and blackthorn. Indeed, the list might be greatly extended—the vegetable kingdom having supplied in most parts of the world almost countless charms to counteract the evil designs of these malevolent beings. In England the little pimpernel, herb-paris, and cyclamen were formerly gathered for this purpose, and the angelica was thought to be specially noisome to witches. The snapdragon and the herb-betony had the reputation of averting the most subtle forms of witchcraft, and dill and flax were worn as talismans against sorcery. Holly is said to be antagonistic to witches, for, as Mr. Folkard‡ says, "in its name

* "British Herbal." † See Folkard's "Plant Lore, Legends, and Lyrics," p. 380.
‡ "Plant Lore, Legends, and Lyrics," p. 376.

they see but another form of the word 'holy,' and its thorny foliage and blood-red berries are suggestive of the most Christian associations." Then there is the rowan-tree or mountain-ash, which has long been considered one of the most powerful antidotes against works of darkness of every kind, probably from its sacred associations with the worship of the Druids. Hence it is much valued in Scotland, and the following couplet, of which there are several versions, still embodies the popular faith:

"Rowan-tree and red thread
Put the witches to their speed."

But its fame has not been confined to any one locality, and as far south as Cornwall the peasant, when he suspects that his cow has been "overlooked," twists an ashen twig round its horns. Indeed, so potent is the ash as a counter-charm to sorcery, that even the smallest twig renders their actions impotent; and hence, in an old ballad entitled "Laidley Wood," in the "Northumberland Garland," it is said:

"The spells were vain, the hag returned
To the queen in sorrowful mood,
Crying that witches have no power
Where there is row'n-tree wood."

Hence persons carry an ashen twig in their pocket, and according to a Yorkshire proverb—

"If your whipstick's made of row'n,
You may ride your nag through any town";

but, on the other hand, "Woe to the lad without a rowan-tree gall!" Possessed of such virtues, it is not surprising that the mystic ash should have been held in the highest repute, in illustration of which we find many an amusing anecdote. Thus according to a Herefordshire tradition, some years ago two hogsheads full of money were concealed in an underground cellar belonging to the Castle of Penyard, where they were kept by supernatural force. A farmer, however, made up his mind to get them out, and employed for the purpose twenty steers to draw down the iron door of the vault. On the door being slightly opened, a jackdaw was seen sitting on one of the casks, but the door immediately closed with a bang—a voice being heard to say:

"Had it not been
For your quicken-tree goad,
And your yew-tree pin,
You and your cattle
Had all been drawn in."

Another anecdote current in Yorkshire is interesting, showing how fully superstitions of this kind are believed: * "A woman

* Henderson's "Folk-Lore of Northern Counties," 1879, p. 225.

was lately in my shop, and in pulling out her purse brought out also a piece of stick a few inches long. I asked her why she carried that in her pocket. 'Oh,' she replied, 'I must not lose that, or I shall be done for.' 'Why so?' I inquired. 'Well,' she answered, 'I carry that to keep off the witches; while I have that about me, they can not hurt me.' On my adding that there were no witches nowadays, she instantly replied: 'Oh, yes! there are thirteen at this very time in the town, but so long as I have my rowan-tree safe in my pocket they can not hurt me.'"

Occasionally when the dairy-maid churned for a long time without making butter, she would stir the cream with a twig of mountain-ash, and beat the cow with another, thus breaking the witch's spell. But, to prevent accidents of this kind, it has long been customary in the northern counties to make the churn-staff of ash. For the same reason herd-boys employ an ash-twig for driving cattle, and one may often see a mountain-ash growing near a house. On the Continent the tree is in equal repute, and in Norway and Denmark rowan-branches are usually put over stable-doors to keep out witches, a similar notion prevailing in Germany. No tree, perhaps, holds such a prominent place in witchcraft-lore as the mountain-ash, its mystic power having rarely failed to render fruitless the evil influence of these enemies of mankind.

Lastly, to counteract the spell of the evil eye, from which many innocent persons were believed to suffer in the witchcraft period, many flowers have been in requisition among the numerous charms used. Thus, the Russian maidens still hang round the stem of the birch-tree red ribbon, the Brahmans gather rice, and in Italy rue is in demand. The Scotch peasantry pluck twigs of the ash, the Highland women the groundsel, and the German folk wear the radish. In early times the ringwort was recommended by Apuleius, and later on the fern was regarded as a preservative against this baneful influence. The Chinese put faith in the garlic; and, in short, every country has its own special plants. It would seem, too, that after a witch was dead and buried, precautionary measures were taken to frustrate her baneful influence. Thus, in Russia, aspen is laid on a witch's grave, the dead sorceress being then prevented from riding abroad.

The first mention of a canal to unite the oceans was made—to assert its impossibility—by an old Spanish historian, P. Acosta, who said, in 1588, that "no human power would be sufficient to cut through the strong and impenetrable bonds which God has put between the two oceans of mountains and iron rocks"; and he added, "If it were possible, it would appear to me to be very just to fear the vengeance of Heaven for attempting to improve the works which the Creator, in his almighty will and providence, ordered from the creation of the world."

SKETCH OF JAMES POLLARD ESPY.

METEOROLOGY is one of the youngest of the sciences. Most of what is settled and systematized has been developed within the memory of men who are still living. The contributions of Americans to research in this branch have been among the most important. Among the earlier labors in this field none deserve or have received wider recognition than those of Prof. Espy. He may, indeed, be regarded with justice as the founder of the science as at present cultivated in relation to storm predictions.

JAMES P. ESPY was born in Westmoreland County, Pa., May 9, 1785, and died in Cincinnati, Ohio, January 24, 1860. While he was still an infant his father moved to the Blue Grass region of Kentucky; but, on finding the institution of slavery antagonistic to the principles inherited from his Huguenot ancestry, he removed after a few years to the Miami Valley in Ohio. One of his daughters had in the mean time married a Kentuckian of Mount Sterling, and James, remaining with this sister for the sake of the opportunity, became, at eighteen years of age, a student in Transylvania University, at Lexington. Here he was visited in 1805 by an elder brother, who was engaged in the practice of the law in Pennsylvania, who wrote of him: "I met my brother James, whom I had not seen since he was an infant. I found him at the university, where he had made considerable progress in the dead languages and in general science. He shows an ardent desire for knowledge, and promises to be both intelligent and useful." He was graduated in 1808, and went to Xenia, Ohio, where he taught school and studied law. Of this part of his career, Mrs. L. M. Morehead, his niece, in her "Few Incidents" * of his life, says that "his love for teaching amounted to enthusiasm, and, although he completed his law studies, he finally abandoned the idea of choosing the law as his profession, and determined to follow the bent of his inclination, and become a conscientious instructor of youth." To his latest years "he considered this a noble profession, and even in old age was fond of drawing out young students to talk over their lessons with him, both hearing them and asking them questions." Either before or after this—the authorities differ—he filled creditably and satisfactorily the position of principal of the academy at Cumberland, Md., where he married Miss Margaret Pollard, who afterward gave him her full sympathy and encouragement in his meteorological researches.

In 1817 Mr. Espy became a teacher in the classical department of the Franklin Institute, a position in which, according to the

* "A Few Incidents in the Life of Professor James P. Espy, by his Niece, Mrs. L. M. Morehead," Cincinnati, Robert Clarke & Co.

late Prof. A. D. Bache, he became known as "one of the best classical and mathematical instructors in Philadelphia, which at that day numbered Dr. Wylie, Mr. Sanderson, and Mr. Crawford among its teachers. Impressed by the researches and writings of Dalton and of Daniell on meteorology," Prof. Bache continued, in a eulogy before the Regents of the Smithsonian Institution, "Mr. Espy began to observe the phenomena and then to experiment on the facts which form the groundwork of the science. As he observed, experimented, and studied, his enthusiasm grew, and his desire to devote himself exclusively to the increase and diffusion of the science finally became so strong that he determined to give up his school, and to rely for the means of prosecuting his researches upon his slender savings and the success of his lectures, probably the most original which have ever been delivered on this subject. His first course was delivered before the Franklin Institute of Pennsylvania, of which he had long been an active member, and where he met kindred spirits, ready to discuss the principles or the applications of science, and prepared to extend their views over the whole horizon of physical and mechanical research. As chairman of the Committee on Meteorology, Mr. Espy had a large share in the organization of the complete system of meteorological observations carried on by the Institute under the auspices and within the limits of the State of Pennsylvania." Mrs. Morehead quotes from the account of a friend who visited him in Philadelphia a description of Prof. Espy's method of pursuing his atmospheric calculations, which necessarily had to be carried on out of doors. The high fence inclosing the small yard was of smooth plank, painted white, while the space inclosed was filled with vessels of water and numerous thermometers for determining the dew-point. The white fence, when last seen by the narrator, was so covered with figures and calculations that not a spot remained for another sum or column. Prof. Espy's theory of storms was first developed in successive memoirs in the "Journal of the Franklin Institute," containing discussions of the changes of temperature, pressure, and moisture of the air, and of the direction and force of the wind, and other phenomena attending remarkable storms in the United States and on the ocean adjacent to the Atlantic and Gulf coast. "Assuming great simplicity," says Prof. Bache, "as it was developed, and founded on the established laws of physics, and upon ingenious and well-directed experiments, this theory drew general attention to itself, especially in the United States. A memoir submitted anonymously to the American Philosophical Society of Philadelphia gained for Mr. Espy the award of the Magellanic premium in the year 1836, after a discussion remarkable for ingenuity and closeness in its progress, and for the almost perfect unanimity of its result."

In 1840 Prof. Espy, by invitation, visited England for the purpose of explaining his theory of storms before the British Association. He presented it, in an elaborate paper, in September, 1840, Prof. Forbes being the presiding officer of the meeting, after which it was subjected to a lively discussion, in which some of the most eminent British scientific men of the day took part, some sustaining it, and some presenting objections to it. He afterward visited Paris, and presented a communication to the Academy of Sciences. The committee to whom the communication was referred, consisting of MM. Arago, Pouillet, and Babinet, at the conclusion of their report, admitted that the memoir "contains a great number of well-observed and well-described facts. His theory in the present state of science alone accounts for the phenomena, and when completed, as Mr. Espy intends, by the study of the action of electricity when it intervenes, will leave nothing to be desired. In a word, for physical geography, agriculture, navigation, and meteorology, it gives us new explanations, indications useful for ulterior researches, and redresses many accredited errors. The committee expresses, then, the wish that Mr. Espy may be placed by the Government of the United States in a position to continue his important investigations, and to complete his theory, already so remarkable, by means of all the observations and all the experiments which the deductions even of his theory may suggest to him in a vast country, where enlightened men are not wanting to science, and which is, besides, the home of those fearful storms. The work of Mr. Espy causes us to feel the necessity of undertaking a retrospective examination of the numerous documents already collected in Europe, to arrange them, and draw from them deductions which they can furnish, and more especially at the present period, when the diluvial rains which have ravaged the southeast of France have directed attention to all the possible causes of similar phenomena. Consequently, the committee proposes to the Academy to give its approbation to the labors of Mr. Espy, and to solicit him to continue his researches, and especially to try to ascertain the influence which electricity exerts in these great phenomena, of which a complete theory will be one of the most precious acquisitions of modern science."

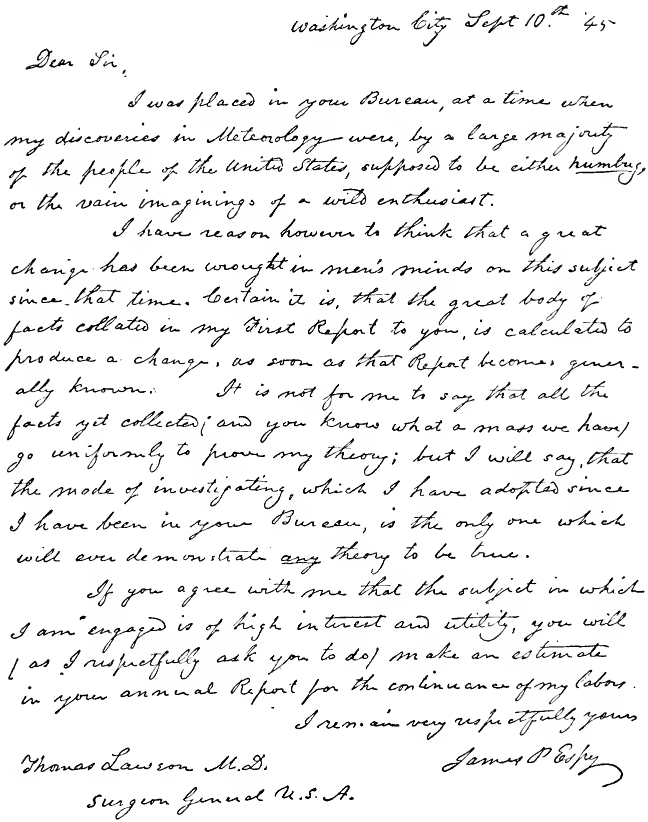
This report was incorporated in full in the introduction to "The Philosophy of Storms"—"not merely," as the author says with characteristic independence of opinion, "for the purpose of showing the reader that I have the highest authority on my side—for I do not submit to authority myself—but to exhibit a beautiful analysis of my theory by three of the most distinguished philosophers in Europe. As a matter of authority, however, I should be justified in bringing forward the report to rebut authority. It had been sneeringly said before a large audience, by a distinguished professor, that I had failed to convince men of science of the truth of my theory, and that I had appealed to the people, who are incapable of judging. It became, therefore, necessary to obtain authority against authority."

The origin of the studies upon which the theory of storms is based is traced in the opening paragraph of the "Philosophy" to the result described by Dalton, that the quantity of vapor in weight, existing at any time in a given place, could be determined by means of a thermometer and a tumbler of water cold enough to condense on its outside a portion of the vapor in the air. "It occurred to me at once," Prof. Espy says, "that this was the lever with which the meteorologist was to move the world. I immediately commenced the study and examination of atmospheric phenomena, determined to discover, if possible, what connection there is between rain and the quantity of vapor in the atmosphere." Prof. Espy prefaced his paper in the British Association by saying that he had found, by examining simultaneous observations in the middle of storms and all round their borders, that the wind blows inward on all sides of a storm toward its central parts; toward a point if the storm is round, and toward a line if the storm is oblong, extending through its longest diameter. The theory is, in brief, that every atmospheric disturbance begins with the ascension of air that has been rarefied by heat. The rising mass dilates, and, as its temperature falls, precipitates vapor in the form of clouds. Owing to the liberation of the latent heat, the dilatation continues with the rising till the moisture of the air forming the upward current is practically exhausted. The heavier air flows in beneath, and, finding a diminished pressure above it, rushes upward with constantly increasing violence. The great quantity of aqueous vapor precipitated during this atmospheric disturbance gives rise to heavy rains. Much of this theory still holds good; but it has been found that the motion of the wind in storms is rotary.

Besides his explanation and proofs of this theory, Prof. Espy presented to the British Association a paper on "Four Fluctuations of the Barometer." The theory was more fully elaborated in "The Philosophy of Storms," which was published in a large octavo volume by Little, Brown & Co., Boston, in 1841, and was re-enforced by detailed descriptions of a large number of storms occurring on the land and the ocean, the course of which the author had been able to follow and study with considerable accuracy. It also contained his answers to the citicisms which had been made against his theory in the British Association and elsewhere by prominent men of science and rival meteorologists. In it, furthermore, he defended his theory that storms could be produced by large fires making local disturbances in the equilibrium of temperature, whence follow ascending currents, cloud and rain. He spent much effort in trying to secure an experimental demonstration of this scheme, and made unsuccessful petitions to Congress and the Legislature of Pennsylvania for appropriations to enable him to carry them out on an adequate scale. The scheme was not regarded as practicable, and he became the object of some ridicule for his enthusiasm—to which he replied in his book with the self-possession of a man who believes to the full in his purposes: "Gentlemen have made their puns on this project, and had their laugh: and I am sorry to see, by letters which I have received, that my friends and relations at a distance are much troubled by these innocent laughs; but let them be consoled: I have laughed too, well knowing that those who laughed the most heartily would be most willing to encourage the experiment as soon as they discovered they had nothing to laugh at. As a proof that I was right in this anticipation, I may be permitted to say that I have lately received a letter from a highly distinguished member of the American Legislature,* who laughed as heartily as any one when my petition was presented them, containing many kind expressions, and promising me, by way of amends for his levity, to avail himself of the earliest opportunity of being better informed on the subject of my new philosophy. Such conduct as this is all I want; I fear not the strictest scrutiny." The same confident spirit is exhibited in his letter to his superior in the War Department, suggesting a second year of employment in the official study of storms, and which is given in fac-simile on the following page.

In 1843 Prof. Espy was given a position in the War Department, where he could pursue his investigations in atmospheric currents and disturbances, and receive reports from distant points of observation. He instituted a service of daily weather reports, out of which our present Signal-Service system has grown; and, on the basis of this enterprise, as Mrs. Morehead relates in her book, Prof. Henry once remarked to her that there was no question in his mind that "Prof. Espy should be regarded as the father of the present Signal Service of the United States, his 'Theory of Storms' having led the way to its establishment and present success." Prof. Henry added that the charts now used in the service were identical (with some modifications) with those that the "Old Storm King" constructed for use in the Meteorological Bureau of the War Department when he was at its head. A similar acknowledgment was made by General Myer. Prof. Espy was for several years a regent of the Smithsonian Institution, and was brought into close relations and friendship with Prof. Henry. On the occasion of his death, Prof.

* Hon. J. J. Crittenden.



Washington City Sept 10^{th} '45

Dear Sir,

I was placed in your Bureau, at a time when my discoveries in Meteorology were, by a large majority of the people of the United States, supposed to be either humbug, or the vain imaginings of a wild enthusiast.

I have reason however to think that a great change has been wrought in men's minds on this subject since that time. Certain it is, that the great body of facts collated in my First Report to you, is calculated to produce a change, as soon as that Report becomes generally known. It is not for me to say that all the facts yet collected (and you know what a mass we have) go uniformly to prove my theory; but I will say, that the mode of investigating, which I have adopted since I have been in your Bureau, is the only one which will ever demonstrate any theory to be true.

If you agree with me that the subject in which I am engaged is of high interest and utility, you will (as I respectfully ask you to do) make an estimate in your annual Report for the continuance of my labors.

I remain very respectfully yours

James P Espy

Thomas Lawson M.D.

Surgeon General U.S.A.

Bache pronounced his eulogy in the Board of Regents, and the Regents passed memorial resolutions, one of which describes him as "one of the most useful and zealous of the meteorologists co-operating with the Institution, whose labors in both the increase and diffusion of knowledge of meteorology have merited the highest honors of science at home, and have added to the reputation of our country abroad."

Prof. Espy delivered many lectures in the towns, cities, and villages of the United States, explaining his theories and the results of his observations. These efforts were very successful, and, according to Prof. Bache, by their originality attracted more attention to his views than could have been obtained in any other way. "He soon showed remarkable power in explaining his ideas. His simplicity and clearness enabled his hearers to follow him without too great effort, and the earnestness with which he expressed his convictions carried them away in favor of his theory." He was also remarkably successful in gaining the sympathy of public men, and, through them, in obtaining from the Government continued opportunities for study, research, and the comparison of observations. His reports to the Surgeon-General of the Army, to Congress, and to the Secretary of the Navy, are mentioned as among his latest efforts in this direction.

Prof. Espy is charged with the one scientific defect that, with his deep conviction of the truth of his theory, and the enthusiasm it fed in him, he could not pass beyond a certain point in its development, and for the same reasons his deductions were often unsafe. He was not prone to examine and re-examine premises and conclusions, but considered what had once been passed upon by his judgment as finally settled. "Hence his views did not make that impression upon cooler temperaments among men of science to which they were entitled, obtaining more credit among scholars and men of general reading in our country than among scientific men, and making but little progress abroad." But, toward the close of his life, he was induced, by the Secretary of the Smithsonian Institution, to re-examine the various parts of his theories, and to insert in his "Fourth Report," while it was going through the press, an account of his most mature views.

Prof. Espy thought much on subjects of mental and moral philosophy, and after his death his relatives in Cincinnati published his short "Treatise on the Will," which is described as embodying some original and striking ideas.

Personally, according to Prof. Bache, "Prof. Espy was eminently social, full of *bonhomie* and enthusiasm, easily kindling into a glow by social mental action. In the meetings and free discussions of a club formed for promoting research, and especially for scrutinizing the labors of its members, and of which Sears C. Walker, Prof. Henry, Henry D. Rogers, and myself were members, Mr. Espy found the mental stimulus that he needed, and the criticism which he courted, the best aids and checks to his observations, speculations, and experiments. But there was one person who had more influence upon him than all others besides, stimulating him to progress, and urging him forward in each step with a zeal which never flagged—this was his wife." Mrs. Morehead says that "he never seemed impatient or concerned at the slow recognition of his discoveries as means of practical use in commerce or other national needs. He would say, 'I leave all this to the future, sure that its adaptation to the uses of life must one day be seen and acknowledged.'"

CORRESPONDENCE.

SILK-CULTURE IN THE UNITED STATES.

Editor Popular Science Monthly:

Those who have watched with interest the struggle to introduce the culture of silk into the United States, and noted the many failures of those engaged in the work, must feel that, if anything is to be done in silk-culture in this country, new methods must be tried. The old plan of urging women to undertake the work in addition to whatever they may be doing seems in every way impracticable. The "New York Tribune," in July, 1885, in dealing with the subject, says: "It is by no means clear that silk-culture holds out any trustworthy prospect to American women. . . . It has been tried pretty thoroughly in California. At Sacramento and San José cocooneries were established, but, though the experimenters in these places had the advantages of an unequaled climate and Chinese cheap labor, they failed, and failed signally. At intervals similar attempts have been made in other States, but the end has always been the same. . . . The raising of silk-worms involves a minute and incessant labor, such as Orientals appear to be alone thoroughly fitted for, and it is not at all adapted to the capacities of American women."

Despite discouragements and failures the Department of Agriculture at Washington still continues to distribute silk-worm eggs, and in the last annual report for the year 1887 it is suggested by Mr. Philip Walker, the agent in charge, that neighbors might save expense, and realize more for their work, by joining together in the use of one hibernating box, one incubator, and one stifling apparatus. It is thought that the interest has been more active this year in the United States than in the year before, and that progress has been made. The only instance given, however, is that of a woman living in Johnson County, Mo., who, assisted by her mother and four children, tried the experiment for two years, receiving for the cocoons $77.90, which, after deducting her expenses, which amounted to $20, left her $57.90 to show for the labor of six people for two years! Certainly not a very profitable occupation, and, judging by this example alone, not one that would offer special inducements to any one that had the slightest idea of the care and work required to raise even a few ounces of eggs. To be sure, the actual time consumed in the care of the worms could not have been more than six weeks of each year; but would not almost any other occupation have paid better than this?

I am indebted to Mr. Edward Atkinson for the fact that, in the year 1886 alone, the United States imported 16,092,583 dozen eggs, amounting to $2,173,454, and the same year imported 1,937,416 bushels of potatoes, at the cost of $649,009. Now, when it is considered that millions of dollars are expended every year for articles which might as well be raised in this country, does it not seem that it would be better for the Government to help along the industries already started here, and leave silk-culture in the hands of those who have successfully carried on the business for years, and who feel well paid at receiving for their work what to an American would seem only a mere pittance?

Mr. John D. Cutter writes in the "Boston Post" for November 10, 1886, as follows: "As an amusement, silk-culture is all right; as a business, it is impossible, for a generation or two to come, or until we are so crowded in the struggle for life that we can do no better for ourselves than to compete with the Chinese for bare existence. . . . No occupation of any civilized or half-civilized people pays its laborers so little as silk-culture. It is the very last employment of humanity this side of starvation. The reason is patent to any one who will look for it; viz., in this industry the competition is with the Chinese, and the product is of such enormous value in proportion to its bulk and weight that distance is no protection to the producer, because raw silk can be carried around the world for one per cent of its value. . . . Silk-culture is no experiment, even in this country; it simply don't pay a people who want to earn more than one cent per hour."

Light and profitable as the work of raising silk-worms is said to be, there are from the very outset risks connected with it. If the eggs are hatched too early in the season, there is danger of late frosts killing the mulberry-leaves, thereby depriving the worms of their food; the worms are easily affected by changes in the atmosphere, and all through the season there is danger of disease; and provided everything goes well, and one is able to sell the cocoons, the price given for them is small compensation for the time and trouble expended, and if, as is so often the case, the cocoons are pronounced worthless, there is nothing to show for the weeks of incessant labor. Many other experiences might be cited to show the absurdity of encouraging competition with the pauper labor of other countries.

Margarette W. Brooks.

Salem, Mass., *December*, 26, 1888.

THE MENTAL FORCE OF WOMAN.

Editor Popular Science Monthly:

No article, perhaps, that has lately appeared in print has called out a more decided difference of opinion than the one entitled

"The Relation of the Sexes to Government," which appeared in "The Popular Science Monthly" for October. Especially has this been marked in Wyoming, for it is here, I believe, that we find the nearest approach to a relation of both sexes with the Government. In the outset of his article Prof. Cope stated that, "being free from the disabilities imposed by maternity, the male could acquire a greater mastery over his environment than the female." Now, in all observations of animal life lower than man, the contrary appears to be the case. We find the female taking the most active part in the struggle for the existence of the young, and certainly doing as much for her own existence as the male for his. The lioness, in providing for and protecting her young, which in animal life represents the home, exerts a much greater "mastery over the environment" than the male, which only for a brief period shows a care for the female, and neither affection for nor government over the young. The horns of the female kine in defense of the calf are to be dreaded as much as those of the male. We do not find the male cat feeding or protecting the kittens. The hen not only provides for and defends but also chastises and governs her brood. In the insect world we find that the female spider eats her husband, bees kill theirs, and female ants make slaves of theirs. Coming to man, we find that among the Indians the female does the drudgery, and also the providing, with the exception of the hunting. In the wild Kurdish mountains we find women doing labor that the beasts of burden fail in, bringing great bundles of fire-wood down those terrible mountain-sides. We find them protecting their fields from the ravages of bears, fighting and slaying them with as much fury as the men, hindered neither by lack of physical strength nor by maternity. Macaulay speaks of a scene in the Scottish Highlands where aged mothers, pregnant wives, and tender girls are harvesting oats, while the men bask in the sun or angle in the streams.

Prof. Cope claims that women would be irresponsible voters, as they can not assist in the execution of the laws that they help make. Does their physical nature prevent them from doing this? In the riots of Ireland, Canada, and the United States does woman stand back hindered by physical weakness from throwing stones, beating the magistrates, or barricading street-car lines? Can it be proved scientifically that man had rather meet infuriated woman in preference to a male antagonist? In the pioneer days did not woman's bullet speed as true to the mark as man's in the protection of her home? Where has woman failed? In the exhausting marches of exiles to Siberia do the facts show that man stands the journey better than the Russian woman?

Again, the professor says, "The mastery by him has accustomed her to yielding, and to the use of methods of accomplishing her desires other than force." This amounts to saying that, while man is superior in force, woman is superior in diplomacy. Now, if it can be proved that in government the latter is as important as the former, then will be shown the absolute necessity for co-operation of the two sexes in political affairs In the garden of Eden we find, instead of Adam choking the apple down the throat of Eve, Eve persuading Adam to partake, and here diplomacy wins. It can not be denied by our most adverse opponents that during the last half-century woman has taken possession of educational government. The teachers of the United States to-day are women. Our sex governs the schools throughout this broad land, and we maintain this government, not through force, but through tact or diplomacy.

Here in Wyoming some experience with woman suffrage has been acquired, though in a Territory of course there can not be as wide scope for its exercise as under Statehood. Now, if it could be believed all over this land that women would allow themselves to be "loaded" into wagons by their man, and driven to the polls to vote his ticket, as the writer of the article in question rudely states it, this would give a mighty impetus to woman suffrage. But this is false. Suffrage is not denied woman because she will vote as man dictates, but because she *will not;* and man knows full well that force would very quickly succumb to diplomacy. It is true we go to the polls in carriages placed at our disposal by the candidates, but is this any proof of disloyalty to our convictions? Are the members of a choir who attend the services of the G. A. R. in carriages provided for them to be accused of having no patriotism nor respect for the honored dead? Is it to be supposed that, in spite of birth, education, or culture, we would become as ignorant vassals to the husbands and fathers whose love, respect, and protection we had possessed, or that our male associates are so debased that they would wish us to become such willingly, or compel us to become so unwillingly? There are women, no doubt, who vote as their husbands vote; but, having been a resident and a voter eleven years in Wyoming, I have yet to find one case where a woman has voted as the *force* of man dictated. There are women in Wyoming who do not vote, but it is not because their male associates compel them to remain at home, and they resent such an imputation. Neither is the woman-suffrage movement condemned by them. The majority of the women in Wyoming vote, and vote according to their own preferences, and the men so desire and expect them to vote. It has been stated, rather coarsely, that woman, for the sake of remaining her own master politically, would be tempted to refrain from *legal* marriage. But were this to prove true, and were woman without a legal protector to step up to the polls to deposit her ballot in opposition to the males, we might look more confidently for exhibitions of force, and, instead of finding woman submitting privately to the maltreatment of her husband, we should see her obliged to suffer publicly the brutality of many men.

I wish that women everywhere would study the one argument that can be brought against woman suffrage. It is this: Woman may reform man. He has shown us clearly that he will not reform himself. Now, unless woman will interest herself in this reformation, she has no business with the ballot. So far woman has done as well as man in the use of the ballot; she has done no better; but she can, if she will. Man has no right to expect woman to take up issues that he ignores, nor has he any right to withhold the suffrage for fear she will do so. But woman in asking for the ballot ought to say to man, We will make better use of it than you have. This is the ground on which we must demand the suffrage. Not the use of the ballot simply to make our own importance greater, but the ballot as it could be used to raise politics out of its filthiness, corruption, and ignorance, and to bring in the reign of purity, patriotism, and intelligence.

THERESE A. JENKINS.

CHEYENNE, W. T., *November* 15, 1888.

EDITOR'S TABLE.

THE DEVIL-THEORY.

IT is a somewhat melancholy thing to reflect that, while we have a ministry of truth in the men who, with dispassionate minds, are applying themselves to discover the laws of nature and the true succession and affiliation of historical phenomena, we have also a ministry of error devoted to opposing, one by one, the conclusions of science, and fostering in the minds of those to whom it is addressed habits of false and inconclusive reasoning. We may quote, as an example of the first, the work of a man like our valued contributor, Dr. Andrew D. White, whose articles on "Demoniacal Possession and Insanity" in recent numbers of this magazine have attracted so much attention. We regret to have to quote as an illustration of the second the recent utterances, on the very same subject, of a man who stands to-day in what but lately was, perhaps, the most progressive pulpit of the whole country, that of Plymouth Church. The Rev. Dr. Lyman Abbott is a man of fine sympathies, of wide culture, and of much moderation of character and judgment. He is a man to whom we should have been disposed to look for steady work in the direction of sound and reasonable views; particularly considering the vantage-ground he occupies as successor to one who, whatever his faults and eccentricities, was ever looking toward the light, and had thoroughly reconciled himself to the leading tenets of modern science. Instead of this, however, we find him accepting to the fullest extent the doctrine of demoniacal possession, and defending it by arguments of the most sophistical character. While the ex-President of Cornell is laboring to banish from men's minds the last vestiges of belief in diabolic agency, the successor of Beecher is handling the devils of ancient narrative with all the tenderness and respect due to the most venerable possessions of the human race. Let us, then, briefly examine what this prominent divine has to say on the topic in question.

Dr. Abbott announces the theory that "evil spirits exercise an influence over mankind." He explains later that by "evil spirits" he means "disembodied spirits"; and adds that there is "nothing unnatural" in their exercising the same kind of control over men that masterful characters exercise over others of weaker will. This hypothesis he holds to be not only scriptural, but more consonant than any other with the facts of science. Charles J. Guiteau, of repulsive memory, he considers to have been a man possessed. "What we call the impulses of our lower nature are often," Dr. Abbott is inclined to think, "the whispered suggestions of fiend-like natures, watching for our fall and exultant if they can accomplish it." This view invests our life with "a greater seriousness and solemnity than we are wont to imagine" as attaching to it, and makes us realize how important it is "to resist the first yielding to one who never becomes the possessor of a human soul *except by its own gradual and voluntary subjection to his hateful despotism*."

We have italicized the last few words of the last sentence for an obvious reason. If any "human soul" has "gradually and voluntarily subjected itself" to evil passions, what need is there to call in the hypothesis of diabolic agency to account for even the worst acts of which the man may be guilty? What says an apostle? "Every man is tempted when he is drawn away of his own lust and enticed." The logical law of parsimony forbids us to suppose anything beyond this. What lusts are, we know; what devils are, we know not, nor have we any means even of certifying ourselves in regard to their existence. Why, then, frame hypotheses beyond all need for them? Moral and physical qualities, there is reason to believe, are inherited. Will Dr. Lyman Abbott, standing in Plymouth pulpit, say: "No, it is a family devil that is inherited; the fiend that tormented the father pursues the son and the grandson"? If he will not say that, if he admits that a given individual may receive by inheritance a certain moral and physical constitution, what difficulty is there in believing that to this source may be traced the deeds which mark for good or for evil that individual's life? Dr. Abbott admits that "we can not demonstrate the influence of an invisible spirit over man"; but neither can we, he proceeds to say, "demonstrate the existence of an ether whose waves produce the phenomena of light." The difference between the two cases, however, is very easily stated. The devils are not required to explain any phenomenon; we can get on perfectly well without that hypothesis: whereas, it was necessary to suppose an ether, in order to render the phenomena of light intelligible, by assimilating them to those of sound, produced, as we have discovered, by the vibrations of another medium. We do not doubt, indeed, that the amiable Brooklyn divine would gladly throw the whole doctrine of devils overboard, as not only useless but hurtful, were it not for the sanction which he understands it to receive from the Scriptures. But if it is to be received on faith, why mar the work of faith by trying to show that it may also be accepted on grounds of reason? Faith is only weakened by such help; and reason, certainly, is not benefited by being put to such forced labor.

Take the case of Guiteau. If he had a devil, why did no one of the hundreds of thousands of orthodox believers throughout the country cast that devil out? What do we read? "These signs shall follow them that believe: in my name shall they cast out devils." Did any one so much as try to cast the devil out of Guiteau? The only utterance we distinctly remember as proceeding from the pulpit at the time was a passionate demand by the eloquent preacher of the Brooklyn Tabernacle for the hanging of Guiteau on a gallows as high as Haman's. If Guiteau really had a devil, it was certainly hard on him that the faith of the Christian world was at so low an ebb that no one cared even to try to relieve him of it. Who knows what an innocent and amiable person he might have become if the uncanny tenant could only have been dislodged? The American nation, however, adopted no such theory. Devil or no devil, they held Guiteau responsible for his crime, and hanged him accordingly.

Dr. Abbott talks of the "gradual and voluntary subjection" of a human soul to the "hateful despotism" of a disembodied fiend. But how does this agree with the New Testament narratives? Are the persons who are there mentioned as having been freed from diabolic possession represented as having deliberately and voluntarily given themselves into the power of the fiends? By no means. They are represented rather as the helpless victims of the Evil One; and when the devils have left them, they are in as sound a moral condition (for aught that is hinted to the contrary) as if they had never been possessed. They are not told to go and sin no more, as was the woman taken in adultery. They are not warned, as Dr. Abbott warns his readers, against putting themselves, of their own free will, in the power of the fiend. Had their subjection to evil been gradual and voluntary, how could their corrupted and debased moral natures have been transformed in a moment by a word addressed not to them, but to the indwelling devils? The fact that on one occasion the devils were gratified by being allowed to enter into a herd of swine would seem to show that personal merit or demerit had nothing to do with their choice of an abode. It is not to be supposed that those particular swine were sinners above all the swine that dwelt on the shores of Gennesaret. If Dr. Abbott will therefore consider the matter candidly, he will see that his theory has the double fault of scandalizing reason and opposing Scripture. Surely it is time that, for men as intelligent and with as liberal instincts as Dr. Abbott, the bands of authority were broken in matters of this kind. What do we want with devils in nineteenth-century thought? Can any honest man say that we need them as a working hypothesis for scientific purposes? Would not such a hypothesis rather prove an obstacle to scientific investigation by drawing attention away from the natural antecedents of crime and insanity? What misery has been wrought by this doctrine in past ages Dr. White has well shown. To-day it is a mere wretched survival from ages of ignorance, and one which a wise man, if he can not afford openly to combat, should at least studiously and conscientiously ignore.

LEARNING TO THINK.

In every-day life no fact is more noticeable than the inability of many persons to do their own thinking, even in matters and upon lines wholly within the range of their intelligence. They will see a point that is suggested to them, and will at once understand its bearing on some matter in hand; but they do not seem to have the faculty or art of raising points for themselves, and consequently their action is not as intelligent as it might be. If given a rule to work by, they will apply it, not only in season but out of season, and will look amazed if one suggests that, under special circumstances, they should have varied their usual procedure. Every employer and overseer of labor knows to what an extent this is the case. It is the exceptional workman who really thinks, and who can therefore be trusted to suit his action to circumstances. And so in nearly every sphere of life; a kind of automatism seems to be the rule, and intelligent self-direction, in the light of present facts, more or less the exception.

One is, therefore, tempted to ask whether, in connection with our systems of education, some gymnastic might not be devised for the special purpose of teaching the rising generation to think. The mere introduction of the natural sciences into school and college courses will not suffice; for, as was shown in a report published in these columns a few years ago, the sciences may be taught with very little intellectual result. What is needed is to form the habit of thought *in connection with everything*; and, without assuming to speak with authority, we can not help inclining to the opinion that this might be done by presenting every object of thought as something not complete in itself, but as requiring, for its proper comprehension, to be considered in its relations to other things. Nearly every act of stupidity committed in daily life arises from disregarding the relations of things—in other words, treating something or other as if it stood apart, in no kind of dependence on anything else. How many such acts would be avoided by the simple reflection that such and such a thing must have had a cause, or that it is sure to have a consequence! How many, by no more profound or acute exercise of thought than is involved in recognizing that a thing can not both be and not be at the same time! How many, by some simple consideration of time, place, or quantity! How many, by a mere question as to the meaning of a word!

One of the main points in education, therefore, ought to be, as it seems to us, to form the habit of treating everything as the possible subject of a great number of questions, some of which at least must be asked and answered before the thing can be, in any true sense, understood. Habit is everything, and if the habit of asking questions, arranged under certain categories, could once be formed, the victory of intelligence over mental inertia would be secured. It is probable that not a little harm is done in the education of the young by unduly appealing to the sense of wonder. Wonder is essentially a stupid emotion; it certainly is the one that stupid people are most eager to gratify. The object of wonder stands alone, challenging attention as being something out of the ordinary course of things. But just in proportion as wonder is excited is rational inquiry discouraged. People do not want to have the marvelous so explained as to bring it into the category of natural and necessary phenomena. From the days of Anaxagoras, who got into trouble for propounding a physical theory of the sun, down to our own time, men have resented explanations of what they have chosen to consider beyond or above explanation. In lieu of wonder, however, we may very usefully stimulate curiosity; and this may be done in a general way by representing everything as leading us on, if properly considered, to views and truths beyond itself—as having its own "aura," as the physicists sometimes say, of force or influence, and certain related objects with which it maintains constant communication.

The successful teacher will be he who, whatever his subject may be, knows best how to present things in their relations; who deals not with unconnected units, but with the vitally connected parts of some organic system of knowledge; and who himself is penetrated by a sense of the interdependence of the truths or propositions that form the matter of his teaching. It ought to be possible to make all instruction subserve the purpose of stimulating thought, of giving to every mind a free activity of its own. The thinking that is required for an intelligent direction of the ordinary concerns of life is not abstruse thinking; it is, on the contrary, in nine cases out of ten, if not in a much larger proportion still, essentially commonplace thinking. We hear from time to time much foolish disparagement of theory as opposed to practice; but there is just this much foundation for the popular prejudice on the subject, that brilliant theoricians are occasionally apt to overlook the simpler and more ordinary aspects of the matters with which they deal; while plain, plodding men, if intent on business, will at least guard the points that most commonly present themselves, and will thus, in the majority of cases, bring things to a successful issue. Educational effort should be most distinctly bent upon giving every human being the habit of asking questions as a preparation for action. The questions need not in most cases be asked of others: it is often enough to raise and distinctly face them; then the answer comes of itself. We have had too many examinations in which the mind is put to a strain, and too little work of the kind involving no strain, but simply tending to keep the mind in a healthy condition of activity and alertness. At home as well as at school, children should be taught to think the thoughts that are suited to their age and capacity; and the neglect of such thought as is quite within their powers should be treated as a fault. We are confident that when a general effort comes to be made for the specific purpose of awakening intelligence, and when, for the furtherance of this end, we throw away a great quantity of the useless lumber with which we now encumber the minds of the young, the result will be a great development of good sense and practical efficiency.

LITERARY NOTICES.

A Text-Book of General Astronomy for Colleges and Scientific Schools. By Charles A. Young, Ph. D., LL. D. Boston: Ginn & Co., 1888. Pp. 550. Price, $2.40.

Prof. C. A. Young's "Text-Book of General Astronomy for Colleges and Scientific Schools" is a work worthy of the reputation of its author, and creditable to the progress of American science. Not only his long experience as a teacher is manifested in the book, but also the character of his teaching, which is clearly that of a man in close sympathy with his students, who perceives accurately the attitude of their minds toward the subject, and knows just when and where to lend assistance. It is no mere compilation, but, to an uncommon extent, an original work. In some text-books of astronomy many things that the really earnest student wants to know seem to have been carefully excluded; he gets results, but not the methods of attaining them, and he can not help feeling that the author has kept him out of the secret, as if it were a performance in prestidigitation. Prof. Young's book is admirably free from this fault. He not only explains principles and methods with unusual distinctness, but he is careful to show the student where to go for further or fuller information. And when he sends the beginner to higher works he starts him off with a clear conception of what he is to go for, which in itself is half the battle. Moreover, he takes pains to point out the limitations of the science—a thing of greater importance than may at first sight appear. For instance, what he says of the nature of the attraction of gravitation is something that the ordinary student rarely gets, but that is of the first importance for a proper comprehension of the subject: "We must not imagine the word 'attract' to mean too much. It merely states the fact that there is a *tendency* for the bodies to move toward each other, without including or implying any explanation of the fact. So far no explanation has appeared which is less difficult to comprehend than the fact itself. Whether bodies are *drawn* together by some outside action, or *pushed* together, or whether they themselves can act across space with mathematical intelligence—in what way it is that 'attraction' comes about is still unknown—apparently as inscrutable as the very nature and constitution of an atom of matter itself; *it is simply a fundamental fact*" (p. 109).

The whole tone of the book is stimulating and suggestive. It is interesting to the general reader as well as to the student. The chapter on "The Earth as an Astronomical Body," for instance, is a beautiful example of comprehensive treatment combined with clear and succinct statement, including, with an explanation of just those principles that the student needs to have made plain, a summary of the latest knowledge which interests everybody. To particularize a little, we have not seen in any work of the kind so perspicuous and satisfactory an account of the Foucault experiments with the pendulum and the gyroscope as that given by Prof. Young.

Among the little things, which are too often entirely overlooked by writers of text-books, but whose suggestiveness and value in awakening the interest of the student, and clarifying his ideas, have been recognized in this book, we note the demonstration of the eastward deviation of falling bodies (p. 94); the explanation of how the height of the mountains of the moon is measured (p. 170); the ingenious proof of the moon's rotation (p. 154); and the stimulating little example on page 123, showing how the eccentricity of the earth's orbit may be found from the greatest and least apparent diameters of the sun.

As was to be expected from the author's wide reputation and recognized authority as an observer of solar phenomena, the chapters on the sun are among the most interesting, instructive, and generally valuable portions of the book. It is worth while to quote two or three passages from these chapters in which he sums up the latest results of investigation and theory. After quoting Secchi's later eruption theory of sun-spots, and pointing out an obvious objection to it, he remarks: "Perhaps the true explanation may be that when an eruption occurs at any spot the *photosphere somewhere in the neighborhood settles down in consequence of the diminution of the pressure beneath*, thus forming a '*sink*,' so to speak, which is of course covered by a greater depth of cooler vapors above, and so looks dark" (p. 190).

In regard to the disputed question of the influence of solar disturbances, as indicated by sun-spots, upon the meteorology of the earth, concerning which some extravagant notions have recently been set forth, Prof. Young says, "It is now quite certain that whatever influence the sun-spots exert upon terrestrial meteorology is very slight, if it exists at all." This statement, coming from one who ranks so high as an authority on solar physics, must be rather discouraging to those who have been trying to fix the responsibility for every great tornado, or other unusually destructive storm of late years, upon some unfortunate sun-spot.

Our author speaks with characteristic modesty, and yet very interestingly, of the phenomenon of "the reversing layer," first observed by him during the solar eclipse of 1870, and which seems to indicate the existence of a gaseous stratum or shell surrounding the photosphere, and not above five hundred miles in thickness, to which the formation of the dark lines in the solar spectrum is mainly due. While by no means abandoning his own opinion of the probable nature of this phenomenon, he frankly states the opposing view of Mr. Lockyer, and points out how observation may be directed to settle the question.

A most inspiring and encouraging statement for those who may be troubled by doubts as to whether any important discoveries remain to be achieved by future students of the sun is that "among the many thousand lines of the solar spectrum only a few hundred are so far identified." There are twelve elements familiar to us on the earth, which are known to exist in the sun, and nine others of whose existence there the evidence is not quite conclusive. Prof. Young does not pronounce quite so positively as some foreign *savants* have done against the validity of Dr. Henry Draper's conclusion that his photographs had demonstrated the presence of oxygen in the sun, but he remarks that the latest work appears to turn the balance of evidence the other way. He still accepts Rosetti's determination of the effective temperature of the sun, 18,000° Fahr., as being the most probable that has yet been obtained.

The extraordinary mental picture that we must form of the solar globe, as a body in the gaseous condition and yet possessing in its nuclear mass a consistency like that of tar, has become familiar to readers of the literature of science since the publication of Prof. Young's admirable book on "The Sun." In the present work he presents in briefer form the same general conclusions concerning the constitution of the sun. There are few who will be disposed to accept by preference the views of those who hold that the great mass of the sun is probably liquid instead of gaseous. The brief synopses given of our knowledge of the nature of the visible phenomena of the sun are exceedingly clear and succinct. To begin with the photosphere, which, as the reader knows, is the visible surface of the sun, from which the splendor of its light arises: "The photosphere is probably a shell of *incandescent clouds*, formed by the condensation of the vapors which are exposed to the cold of space.

"The photospheric clouds float in an atmosphere containing, still uncondensed, a considerable quantity *of the same vapors out of which they themselves have been formed*, just as in our own atmosphere the air around a cloud is still saturated with water vapor. . . .

"The chromosphere and prominences are composed of the *permanent gases*, mainly hydrogen and helium. . . . The appearances are for the most part as if the chromosphere was formed of jets of heated hydrogen ascending through the interspaces between the photospheric clouds, like flames playing over a coal-fire.

"The corona also rests on the photosphere, . . . but extends to a far greater elevation than even the prominences ever reach, and seems to be not wholly gaseous, but to contain, besides the hydrogen and the mysterious 'coronium,' dust and fog of some sort, perhaps meteoric."

While the part of the book devoted to the sun is so excellent, it must not be supposed that the other divisions of the subject have not received adequate attention. In fact, one of the strong points of the work is that it is well balanced, and the student gets as complete a view of the science as is possible within the limited space of a school text-book. The author, in setting forth with uncommon clearness the elementary mathematics of his subject, has not ignored what may be called its philosophical aspects. He has, for example, given an account of the nebular hypothesis which, notwithstanding its brevity, can not fail to be of much use in dissipating the fog that hangs over this whole subject in the minds of those who have little knowledge of astronomy beyond what has been vouchsafed to them in the ordinary college curriculum. We should have been pleased to see from Prof. Young's pen an elementary account of George Darwin's remarkable theory of "tidal evolution," in place of the references that are given to other popular explanations of that subject.

Recent discoveries have carried us so far into the depths of space that there is nothing within the circuit of astronomical knowledge and investigation which appeals more strongly to inquiring minds than the relations of the solar system to the universe without. Such achievements in observation as those of the Lick telescope, and the recent surprising advances in astronomical photography, promise us much light upon the old problem of the structure of the heavens. Prof. Young's remarks in the present work on the distribution and motions of the stars, though brief, are fruitful in suggestion. We quote the following passage as a particularly interesting generalization: "In the solar system the central power is supreme, and perturbations or deviations from the path which the central power prescribes are small and transient. In the stellar system, on the other hand, the central force, if it exists at all (as an attraction toward the center of gravity of the whole mass of stars), is trifling. Perturbation prevails over regularity, and '*individualism*' is the method of the greater system of the stars, as solar despotism is that of the smaller system of the planets."

This remark, which is fully justified by all we now know of stellar motion, presents a very different picture of the universe from that which has sometimes been drawn for the edification of admiring congregations, of planets circling around suns, and suns around other suns, and these systems around grander systems still, and finally the whole universe revolving with a stupendous orbital sweep around the great center of all, the throne of the Creator himself! It appears that things don't revolve that way.

There are many good features in the book that we should like to point out if space permitted. It may be remarked, by the way, that a fine example of the author's desire to convey practically useful information is the italicized sentence on page 35: "*Never turn the hands of a chronometer backward.*"

It goes without saying that the more mathematical parts of Prof. Young's work are highly excellent, succinct, and clear. Such subjects as central forces, the tides, parallax, the equation of time, and perturbations are treated in such a way as to give the student a sure insight into the nature of the problems involved.

The illustrations accompanying the text are good, many being original, and some excellent ones borrowed from the author's book on "The Sun" (published by Appletons), and from other sources. Some useful tables of elements and constants, based upon the most recent information, close a book which, it is not too much to say, will be scarcely less welcome to the general reader than to the students for whose instruction it is intended.

Force and Energy: A Theory of Dynamics. By Grant Allen. London and New York: Longmans, Green & Co. Pp. 161. Price, $2.25.

Mr. Allen's theory does not aim to revolutionize the generally accepted ideas concerning force, but is rather an attempt to classify the known forms of force, and systematize their relations. Under the general term power he includes forces and energies, distinguishing them by their effects. Thus, he defines a force as a power which tends to bring together portions of matter (and possibly of ether), while an energy has the opposite effect. He divides forces into four species: gravitation, which aggregates masses of matter; cohesion, which aggregates molecules; chemical affinity, which aggregates atoms; and "electrical affinity," which aggregates "electrical units." An instance of the operation of this last force is the discharge of a Leyden jar, by which positive and negative electricities are brought together. "In our present ignorance of the subject," he says, "electrical affinity must be placed in the same category as other forces; though further researches will doubtless enable us to give a better account of its real nature." Of the unit on which this force acts, the "electrical unit," he says that its nature "is very inadequately known to us," but that it "must be considered for our present purpose as in some way the analogue of the others, though we have no sufficient warrant for giving it any material properties." For further particulars he refers to a chapter on "Electrical Phenomena," but diligent search fails to discover such a chapter in the book. The author divides energies on the same principle as forces. "But owing," he says, "to the existence of two modes of energy, the potential and the kinetic, it will not be possible to assign a single definite name to each species." An instance of the action of a "molar energy" is afforded when we lift a weight from the ground. Heat, which separates molecules, is a "molecular energy." As an instance of a "chemical energy" employed in separation, he gives the power which effects the electrolysis of water. Hence, if we understand Mr. Allen rightly, the action of a current of electricity in electrolysis is the action of two powers of opposite kinds. For his aggregative power, or force, "electrical affinity" must be acting between the poles of the battery immersed in the water, while his separative chemical power, energy, is tearing apart the atoms of hydrogen and oxygen. He mentions light and intense heat as other examples of chemical energy. His instance of (separative) "electrical energy" is the friction which produces a disunion of the positive and negative electrical units in the electrical machine. But he adds that "as in the case of electrical forces, our treatment of this department must be considered purely temporary and symbolical." There are two modes of energy, the potential and the kinetic, and each of the four species of energy may exist in either mode. Motion has three kinds: separative, aggregative, and continuous or neutral. Each species of kinetic energy has a form of each kind. The principle commonly called the conservation of energy Mr. Allen names "the indestructibility of power," applying the former term in accordance with his use of the word energy, while he uses "the persistence of force" to denote the indestructibility of "aggregative power." In stating these principles the author gives us another distinction between force and energy, the former being inherent in the particles of matter, never passing from one unit to another, while energy may be transferred from one particle or set of particles to another. Not only do energies oppose forces, but one force may "interfere" with another: thus, when a weight is suspended by a cord, the cohesion of the cord counteracts the force of gravitation. So also energies may be "suppressed" by forces or by other energies. "Liberating energies" are those which release bodies from the control of one force and bring them under that of another.

With two short chapters on the nature of energy and the nature of motion the author closes the "abstract or analytic" part of his book. In the "concrete or synthetic" part, which follows, he describes the operations of force and energy in the evolution of the sidereal system, the solar system, the earth, and organic life, closing with a general view of the energies which the earth possesses. In an "apology" prefixed to the volume the author states that he has kept his theory in manuscript for a number of years, and explains why it is now published. "It pretends to be," he says, "no more than a suggestion, an *aperçu*, an attempt at a theory: I ask for it nothing better than honest consideration."

Hume's Treatise of Human Nature. Edited by L. A. Selby-Bigge, M. A., Fellow and Lecturer of University College. Macmillan & Co., Clarendon Press. 1 vol., pp. 709. Price, $2.25.

This celebrated treatise is now reproduced in admirable style, containing, in addition to the text, the original title-pages of

1739 and 1740; the original advertisements, and a critical index by the editor; the latter intended, in the language of the preface, to "point, not loudly but unmistakably, to any contradictions or inconsequences and . . . to any omissions of importance." This valuable index occupies thirty pages of fine print. Altogether, the present edition is a credit to all who have been concerned in its preparation; and no inconsiderable service is done to philosophy by thus calling attention again to the great importance of Hume in the development of philosophical thought.

The "Treatise of Human Nature" was finished by Hume when he was scarcely twenty-five years old; and its final composition occurred in the village of La Flèche, in France, where his philosophical predecessor, Descartes, was educated. The result of its publication, in England, was, to use the author's own language, that "it fell dead-born from the press, without reaching such distinction as even to excite a murmur among the zealots." It was not till his "Essays, Moral and Political," were published (1741–1748), and achieved notable success, that any measure of attention was bestowed upon the "Treatise"; and indeed the significance of the latter in the history of philosophy was not made manifest till the world became acquainted with Kant's "Critique of Pure Reason," which was first published at Riga in 1781.

This relation between Hume and Kant can be studied to advantage in the Introductions to Hume's works by the late Prof. T. H. Green, of Oxford, who was the leader of the Hegelian *coterie* of that institution. These Introductions are now accessible in a separate volume (Longmans, Green & Co., 1885). If Green's statements were limited to the English experiential school, before the doctrine of evolution appeared as a factor in philosophical thought, they would not stand in so much need of correction. As they are, however, they do need correction; but, nevertheless, they exhibit tolerably well the true position of Hume as the precursor of Kant. The former marked the close of an epoch, that of the course of thinking of which Locke was the progenitor. To Kant's mind Hume demonstrated the necessity of a new point of departure and a new method. This invests the "Treatise of Human Nature," his most important work, with a peculiar interest. To use Green's language, but with a less wide application of the terms "old" and "new"; the "Treatise" and Kant's "Critique" "taken together, form the real bridge between the old world of philosophy and the new. They are the essential 'propædeutik,' without which no one is a qualified student of modern philosophy."

The reader who desires to learn something more about Hume will do well to peruse the little volume entitled "Hume," of the Blackwood series of "Philosophical Classics for English Readers," written by William Knight, LL. D., Professor in St. Andrews University. This book gives both a good biography of Hume and an outline of his philosophy, a great deal in small compass; though, as in the case of Green's works, the reader of Knight's volume must be on his guard against a strong bias adverse to Hume's philosophy, and indeed to that of the English experiential school generally.

Down the Great River: Embracing an Account of the Discovery of the True Source of the Mississippi, etc. By Captain Willard Glazier. Philadelphia: Hubbard Brothers. Pp. 443 + liii. Price, $2.

In this book Captain Glazier relates the story in full of his journey, in 1881, by the aid of an Indian guide, "across country," from Brainard, Minnesota, to "Glazier Lake," south of Itasca Lake, and his determination of it as the real source of the Mississippi River. The journey was made first to Leech Lake, which is on one of the main affluents of the upper Mississippi, and is the seat of an Indian agency, and thence up a chain of lakes and portages, through a territory of which very little if anything was definitely known, to Itasca Lake; around Itasca Lake to the largest stream flowing into it; up that stream to "Glazier Lake," and around that lake till the author was satisfied that nothing important was likely to be found above it. Thence Captain Glazier descended in canoes, through all the windings and the lakes of the main stream of the Mississippi, and down the river to its mouth; the whole of this journey being performed in one hundred and seventeen days. He claims that his is the only party that has thus explored the whole length of the river. As determined by the author, "Glazier Lake" is in about latitude 47°; is 1,585 feet above the level of the sea, and is 3,184 miles from the Gulf of Mexico. The river reaches its highest northing at Lake Bemidji, in the neighborhood of latitude 47° 30′. Captain Glazier's claims to be the discoverer of the true source of the Mississippi have been disputed by some persons, who have affirmed that the lake which has been named after him was not unknown to Schoolcraft, and that it has been visited by hunters. The author replies to these objectors by affirming that, no matter how many persons may have known of the existence of that body of water, he was the first to explore it, to gauge its dimensions, and to determine that it is the ultimate source of the Mississippi; and he cites a large number of declarations of geographers and of men versed in the history, geography, and traditions of Minnesota which support his claims in this shape. He represents "Glazier Lake," though its superficial area is less, as being deeper and containing more water than Itasca Lake. The story of the explorer's journey is very pleasantly narrated, with descriptions of the notable points along the river and the more striking scenes, and is embodied in a neat volume which is adorned with appropriate illustrations.

Lectures on Pedagogy: Theoretical and Practical. By Gabriel Compayré. Translated, with an Introduction, Notes, and an Appendix, by W. H. Payne, A. M. Boston: D. C. Heath & Co. Pp. 491.

Although deeming that the best system of teaching "which we make for ourselves through study, experience, and personal reflection," M. Compayré says also that "in order to aid the reflection and guide the experience of each novice in instruction, the book is very far from being useless though it do nothing more than stimulate personal reflection. It is just in this spirit, less for imposing doctrines than for suggesting reflections, that this modest volume has been written." He divides the treatise into two distinct parts, theoretical pedagogy and practical pedagogy. In the first part, after a general consideration of the function and limits of education, the author states the general principles of both physical education and intellectual education, and then takes up the special culture of the various faculties, beginning with the education of the senses. Besides treating of the essential faculties which are constantly being employed in mental operations, he makes a plea for the culture of the imagination, justifying this tribute to its importance by a quotation from Mr. Blackie, who says: "It is the enemy of science only when it acts without reason—that is, arbitrarily and whimsically; with reason it is often the best and the most indispensable of allies." The education of the feelings is also urged in a chapter which leads up to the subject of moral education. Æsthetic and religious training are likewise included in the scope of education. Under practical pedagogy, methods of teaching and rules of school management are treated. In regard to the importance of method he says: "There is nothing to be expected from a discipline which is hesitating and groping; from instruction which remains incoherent and disorderly, which fluctuates at the mercy of circumstances and occasions, and which, being wholly unpremeditated, allows itself to be taken at unawares." The principal methods of teaching to read are first described, some advice on the teaching of writing is given, and the simultaneous teaching of reading and writing is touched upon. The author has a chapter on object-lessons, pointing out their true character, and telling how they have been distorted by some teachers. In dealing with the study of the mother-tongue he points out some general principles, and tells the special use of grammar, dictation exercises, analysis, composition, elocution, and literary exercises in teaching knowledge of language. The teaching of history and of geography are treated in like manner. His chapter on the sciences is devoted mainly to arithmetic and geometry, while the physical and natural sciences are disposed of in three pages. He seems inclined to rate the acquirement of facts as a more important purpose of science-teaching than the formation of the habit of observation; therein, as in what few other suggestions he gives on this subject, following the French official programme of instruction. Methods of moral and civic instruction, and the teaching of drawing and music, are treated in some detail. Manual labor for boys, agriculture, and military drill, manual labor for girls, sewing, and domestic economy, are touched upon. The two closing chapters deal with rewards and punishments, and discipline in general. The text is divided into paragraphs, each with a title. Throughout the volume the author makes evident his belief that a living, active personality is needed in addition to rules and formulas, in order to make any system of education effective.

Civilization and Progress. By John Beattie Crozier. London and New York: Longmans & Co. 1888. Pp. 477. Price, $1.50.

In this work there is much to commend. The defect seems to be a failure to properly condense and clarify the thought. Again, there is, perhaps, too much reference to particular men as exponents of intellectual movements. Not that names should be neglected, but more prominence is given to the person than to the thought represented; leading to the false impression that men make an epoch instead of the truth that the epoch makes men, who are only representatives of the intellectual feeling of their times. But, apart from these matters of minor criticism, the book is a most excellent one, for the reason that the author aims to show, and succeeds in showing, the controlling factor in any social progress "to be the material and social conditions, and not, as so many believe, moral exhortation and appeal." This rests on the law that "in this world things make their own relations—that is to say, their own morality—in spite of politicians or priests. Now, should this turn out to be a true law, it will not only settle speculatively the basis on which civilization rests, but will also furnish a practical guide for action. Its importance, therefore, can not be overestimated. For if the moral relationships of the great masses of men—their ideals, opinions, and habits of thought—grow directly out of their conditions of life, it is evident that, instead of sitting invoking (*sic*) a lofty morality which will prove as obstinate as the fire invoked by the priests of Baal, it behooves us rather to set to work resolutely to bring about that amelioration in the material and social conditions without which the higher morality can not arise." This is a truly scientific position to assume, and the fact that the author takes it entitles his work to the consideration of disciples of science. As to the value of the idea set forth, there is much force in the author's contention that we ought to regard with serious attention the question whether we can have any such thing as equality or security in rights unless there be substantially a social equality of power. If power be unbalanced, the stronger will oppress the weaker, and endeavor to perpetuate its domination at the expense of the latter. This process will go on till the pressure of the more powerful becomes unbearable, and provokes violent and destructive eruptions leading to all sorts of convulsions. Hence we must not expect any stable social equilibrium unless there be an equality of power—that is to say, of material and social conditions.

Accessory to this central thought of Mr. Crozier's work are many interesting criticisms, historical, political, religious, and ethical. The book is worthy of careful study, and is a genuine contribution to sociologic science.

In his *Complete Graded Course in English Grammar and Composition* (D. Appleton & Co.), Mr. Benjamin C. Conklin has endeavored to compass with a single volume the entire range of the usual *two-book* course. This he does by making it sufficiently elementary in the beginning to be put into the hands of pupils in the lowest grammar grades, and sufficiently advanced to cover all that is required of the highest grammar classes. The theory of the book is the gradual development of the sentence; the method inductive. The teachings of the text are exemplified by graded sentences, which in themselves afford a concrete presentation of the whole subject; and these are accompanied by questions so framed as to require the pupil, after a study of the text, to formulate his own answers. Analysis and synthesis are so carried along together as to develop, with the knowledge of the structure of the sentence, the power to use language. Instead of giving examples of false syntax for correction, a better way is sought of accomplishing the same object by presenting exercises for filling out sentences by supplying the correct forms of words in blank spaces. But examples of false syntax are given in an appendix, for teachers who prefer them.

In the *High-School German Grammar* of *W. H. Van der Smissen* and *W. H. Fraser* (D. Appleton & Co.), while the lessons and exercises have been made progressive as far as possible, each separate subject is fully treated before being dismissed. Care has been taken that no grammatical point shall occur in any sentence on which the pupil has not been previously instructed, and that the principles of past lessons as well as of the current lesson shall appear in every exercise. Supplementary lessons, designed mainly for reference, are devoted to special cases of grammatical usage. Those points in which German differs from English usage, particularly with regard to the prepositions and their puzzling idioms, the use of participles and the construction of participial clauses, and the order of words and construction of sentences, are explained. The vocabulary gives such meanings of words as occur in the exercises; and the index is full.

American educators now have offered to them the *Systems of Education* of Prof. *John Gill* (Heath, $1.10). The work is a history and criticism of the educational principles, methods, organization, and discipline which have been in use in England, and consists of lectures which it became the author's duty to prepare, as Professor of Education in the Normal College, Cheltenham. The first man whose ideas produced an important effect on English education was Roger Ascham, and his "Scholemaster," though dealing primarily with classical teaching, yet contains principles which are applicable to all school subjects. Comenius, Milton, Locke, and Vicesimus Knox are the other educationists whose teachings have been influential in shaping the grammar schools of England. The Edgeworths and Pestalozzi are credited with most strongly modifying the development of the common school. Oberlin, Wilderspin, the Mayos, and Froebel are the most prominent names in the history of infants' schools. In the conduct of the elementary school, designed for pupils whose education will not proceed far, Dr. Andrew Bell, the founder of the monitorial system, has the earliest place. Joseph Lancaster, a contemporary of Bell, employed substantially the same methods. Without displacing the monitorial organization, there grew up after a time what was called the intellectual system, which made the culture of the intelligence its special aim. A further advance in the same direction was made by David Stow, who devised the training system, which is here presented with especial fullness. The book closes with a chapter on amateurs and helpers, who, though not professional teachers, have had more or less influence in developing systems of education.

In the *Report of the Commissioner of Education for* 1886–'87 (Government Printing-Office), the commissioner, Hon. *N. H. R. Dawson*, states that the bureau has undertaken to investigate the history of American education, beginning with the sections of the country whose educational history is comparatively unknown. Monographs on William and Mary College and the University of Virginia, with sketches of other Virginian colleges, have been prepared. The commissioner devotes considerable space to telling the condition and needs of education in Alaska, where he has personally made a tour of inspection. Since his appointment, he has simplified the organization of the bureau, and has succeeded in hastening the publication of the annual reports. The volume contains the usual information about the schools of the country, and an index to the publications of the bureau, from 1868 to 1887, with a list of the same.

The second of the "Contributions to American Educational History," now being published by the Bureau of Education, is on *Thomas Jefferson and the University of Virginia*, by Prof. *Herbert B. Adams*, and contains also authorized sketches of Hampden Sidney, Randolph, Macon, Emory, Henry, Roanoke, and Richmond Colleges, Washington and Lee University, and Virginia Military Institute. Jefferson's efforts in the cause of education, and the history of the establishment of the University of Virginia, are given with much fullness. An interesting chapter in the account tells how the example of this university over sixty years ago aided the birth of what is now called "the Harvard idea." The record is made more valuable by numerous illustrations, part of them, including a portrait of Jefferson, being borrowed from a recent article on Jefferson in

"The Century." Views of the buildings of the other colleges described are also given. Several special articles on the university are contributed by various writers, viz.: "Influence of the University upon Southern Life and Thought," and "The Writings of the Faculty of the University, 1825-'27," by William P. Trent, A. M.; "Present Organization and Condition of the University," by Prof. John B. Minor; "The Elective System of the University," by Prof. J. M. Garnett; and a "Bibliography of the History of the University," by the editor.

The book on *Manual Training in Elementary Schools for Boys*, by *A. Sluys* (Industrial Education Association, New York, Part I, 20 cents), will form Nos. 7 and 8 in the series of monographs published by this association. The author is principal of the Normal School of Brussels, and has studied the subject of manual training in Sweden, whither he was sent for this purpose by the Belgian Minister of Education. His book has been translated for this series, with the belief that it is the best and most accurate as well as the most condensed treatment of the subject that has yet appeared in any language. In the first part of this work, now before us, the author states the two standpoints from which manual training is advocated, the economic and the pedagogic, giving a somewhat detailed view of the economic side of the subject. An account of the schools of Nääs, and a history of instruction in manual training in the primary schools of Sweden, are the other topics treated in this portion of the book. There are some traces of the translation process in the English of this pamphlet. We note, for instance, the expression "whets the saw," and on the same page the visitors are made to say, "We have often assisted the pupils in their manual work at the Nääs school," where the original phrase undoubtedly meant "to be present at"; and in the Gallicism "assisted at," at the foot of the next page, the translator has reproduced the form of the same phrase instead of its meaning.

In his oration on *The American University*, delivered at Columbia College, June 2, 1887, Prof. *Charles Sprague Smith* expresses the view that the future university of this country must be formed in harmony with the development of the American people; that the last two years of the usual college course may be taken as the first two of the university, relegating the present freshman and sophomore work to a preparatory course; that election of courses rather than of separate studies should be allowed in the university, and but little or no election in the academies; and that the scope of the university should be twofold—to instruct the few and to enlighten the many.

Prof. *Robert T. Hill* delivered before the University of Texas, October 26, 1888, an inaugural dissertation on *Some Recent Aspects of Scientific Education*, in which he points out that the introduction of the study of the natural sciences into the modern system of education has had a vast and beneficent influence on the popular mode of thought, and of searching for truth, on the public health, on the art of agriculture and the mechanical arts, on our knowledge of man, on the methods of education itself, and on the progress of sociology. He touches also upon the benefits of the extension of university study into the homes of the people.

According to Secretary *S. P. Langley's Report*, the Smithsonian Institution is overtaking the capacity of the fund to sustain it, and is beginning to need larger resources. New accommodations are needed for the National Museum; the library, now including 250,000 volumes, and extremely valuable, is so crowded in the Congressional Library rooms as to be of little use; the erection of an astro-physical observatory is suggested. The first part of Prof. Cope's work on the reptiles and batrachians of North America is in the hands of the printer. Explorations are mentioned in Japan, the islands of the Gulf of St. Lawrence (for remains of the great auk), Central America, and Alaska. A steady falling off is remarked in the rate of addition to the quarto series of Smithsonian "Contributions," while the series of "Miscellaneous Collections" grows much more rapidly. The recent accessions to the museum (12,000 groups or lots of specimens since the present building was opened) include several extensive collections. The increasing popularity of this department is proved by the increase of 32,463 in one year in the number of visitors (249,025 in 1887-'88). A higher standard than the average is claimed for the clerical force of the Institution, and its excellence is attributed to the absence of politics.

The sixth and seventh parts of Mr. *Richard A. Proctor's Old and New Astronomy* (Longmans, Green & Co., London and New York) relate to the physical functions and constitution of the sun and to the planet Mercury. The author's method of treatment is clear and interesting; he is well at home in the subject, and has endeavored to serve it in this book as one should serve the chosen and ultimate work of his life. The publishers have done their part in making the work attractive, presenting a page of pleasant aspect, abundantly illustrated with figures intended to make the text more easily intelligible, and engraved in a style that leaves nothing to be desired.

Several monographs have been sent us by Dr. *Alexis A. Julien*—reprints of papers read during several years past before scientific societies. The one among them of the most direct value is that on the *Decay of the Building-Stones of New York City*, in which the various stones employed in architecture and their several qualities—particularly those affecting their durability—are described. In the *Genesis of the Crystalline Iron Ores*, the various theories on the subject and the author's conclusions are given.—*The Sealed Flasks of Crystal* calls attention to the liquid inclosures in crystals, which are more frequent than they are known to be, explains their occurrence, and tells how to find them.—A double paper *On the Variation of Decomposition in the Iron Pyrites; its Cause, and its Relation to Density*, besides the features of treatment suggested, tells many things concerning a common mineral, in a style acceptable to the general reader.—Other papers in the list are *On the Geology of Great Barrington, Mass.; Notes on the Glaciation of the Shawangunk Mountain, N. Y.; The Dunite Beds of North Carolina;* and the *Volcanic Tuffs of Challis, Idaho, and other Western Localities.*

According to the *Report of the State Mineralogist, W. J. Irelan, Jr.*, the State Mining Bureau of California is satisfying a want which the State has been in much need of since the beginning of quartz or ledge mining. It is gathering the records of the earliest mining ventures, collecting statistics of present developments, studying the methods of recovery of the precious metals, examining the unexplored mineral sections, determining the lithological structure of the inclosing rocks, and making known to the world the mineral resources of the State. It has collected an extensive museum of specimens, and is accumulating a valuable library of books treating on the subjects for which it was created. The report for 1888 treats all of the counties of the State separately, with all matters bearing upon their mining interests and development; and its nine hundred and forty-nine pages are full of information respecting the geology, mineralogy, mines, method of working, machinery, and results of each district.

The Reports and Bulletins of the Agricultural Experiment Stations, whether examined collectively or separately, furnish information of value, to a large extent fresh. One from *Hatch Experiment Station of the Massachusetts Agricultural College* (No. 3, January, 1889) is devoted chiefly to *Tuberculosis.*—The *Annual Report* of the *Connecticut Station* for 1888 includes a paper on *Fertilizers*, their analysis and value; *Bulletin* No. 96 of the same station (January, 1889) is on the *Valuation of Feeding-Stuffs.*—*Bulletin* No. 2 (October, 1888) of the *Storrs School Station*, Mansfield, Conn., records *Experiments on the Effects of Tillage upon Soil Moisture.*—*Bulletin* No. 4, of the *New York Station*, Geneva, is on the *Chemical Composition of some Feeding-Stuffs* (grasses, clovers, forage-crops, grains, and by-products).—*Bulletins* Nos. 3 and 4 of *Cornell University Station* (November and December, 1888) relate to certain insects and to the growing of corn for fodder and ensilage.—*Bulletin* No. 3 of the *University of Illinois Station* (November, 1888) relates to *Field Experiments in Oats.*—*Bulletins* Nos. 2 and 3 of *Iowa Agricultural College Station* contain thirteen articles on "Corn-Tassels, Silks, and Blades"; "Characteristics of Hardy and Tender Fruit-Trees"; "Promising New Fruits, Grasses, Insects, and Insect Remedies," and other subjects.

The Report of the Commissioner of Internal Revenue, Hon. Joseph S. Miller, for the last fiscal year, deals chiefly with tobacco, spirits, substitutes for butter, and adulterations. A large increase is shown in manufactures of tobacco and collections therefrom, while the manufacture of spirits decreased during the year by 7,552,193 gallons, the decrease being wholly in whiskies and high-wines. A large and valuable portion of the report deals with butter substitutes, and the laws and regulations of different countries respecting them and adulterations. The commissioner also publishes, as a separate document, the *Regulations for the Analysis of Foods and Drugs in the District of Columbia;* to which is appended a list of substances that are dangerous or that are harmless when present in foods. Bibliographies accompany both pamphlets.

With the new year several new periodicals have come into being and invite attention. The *Cumberland Presbyterian Review* is a quarterly publication, devoted to theology and the discussion of current religious, literary, and scientific topics, and questions connected with church work and moral reform. It is edited by J. M. Howard, D. D., and published at Nashville, Tenn., by the Board of Publication of the Cumberland Presbyterian Church. Among the articles we note those of President A. B. Miller, on the "Physical Basis of Moral Reform"; Prof. Hinds, on "Charles Darwin"; Prof. Tigert, on "Our Senses, how we use them, and what they tell us"; and T. M. Hurst, on the "Decay of Christian Citizenship," as probably most likely to interest our readers. *The Collegian* is a monthly, devoted to the interests of undergraduates, edited by *Samuel Abbott*, and published at Boston under the auspices of the *Intercollegiate Press Association.* It aims to be the central organ of our four hundred and fifty or more colleges, with their more than one hundred and eight thousand students; and is to be, except for the "special paper," the work of undergraduates. The paper, "A Worker in Stone," in the first number, is a truly scientific study of Indian relics. Another paper claiming attention is a symposium, or collection of letters on "The Influence of Athletics upon the Curriculum." *Germania* is a fortnightly journal for the study of the German language and literature, edited and published by A. W. Spanhoofd, at Manchester, N. H. It will attempt to teach the language and to acquaint its readers with the best of German literature by publishing graded reading exercises and selections from the representative authors. *The Educator*, *W. H. Smith*, editor, Buffalo, monthly, September to June, will undertake to give to persons in schools knowledge of what is going on in the world; of affairs of the State and nation, scientific adventures and discoveries, and the good in literature. Pp. 16, $1 a year. *Electric Power*, *R. W. Pope* and *G. H. Stockbridge*, editors (Electric Power Publishing Company, New York), is devoted to the interests of the electric railway, and of the transmission of power by electricity for industrial purposes. Monthly. Pp. 24, $3 a year. *The Business Woman's Journal*, *Mary F. Seymour*, editor and publisher, New York, is a monthly devoted to the interests of all women, especially of those engaged in active pursuits. It believes that women may succeed in every sphere of life, and will advocate the recognition of their right to have their success acknowledged; "will be the organ of no special reform, but of all," and "will look at the woman's side of every question." Pp. 24, $1 a year.

President G. Stanley Hall's American Journal of Psychology, now in its second volume, well carries out the high purpose with which it started. In the latest number, Prof. Sanford gives a study of the "Personal Equation," including the history of the observations and the results of the investigations that have been made on the subject; Dr. W. H. Burnham considers the "Memory" from the historical and experimental points of view; and Mrs. Putnam-Jacobi discusses "The Place for the Study of Language in a Curriculum of Education." In the notices in "Psychological Literature," which include many titles, works and papers on the nervous system are reviewed by Prof. Donaldson, and those in the experimental field by Prof. Jastrow. $5 a year.

The *Harvard Law Review*, monthly, is published by students of the Harvard Law School, with George R. Nutter as chief of the editorial board. The numbers for October and November, 1888, contain an essay by Mr. Samuel Williston on the "History of the Law of Business Corporations before 1800," which received the prize offered by the Harvard Law School Association—a prize which has the promise of becoming an annual one, at least for several years to come. A summary of the "Liquor Statutes of the United States" is given by William Church Osborn in the October number. The general list of contributors includes several publicists of national fame; 35 cents a number, $3.50 a year.

The *Manufacturer and Builder*, *W. H. Wahl*, editor (Henri Gerard, publisher, New York), now in its twenty-first year, is devoted largely to the building trades, and whatever relates to them, and well occupies its field, which it makes to cover a wide range of subjects. The number for January, 1889, shows continued improvement. Among other matters it has a review of progress during 1888. $1.50 a year.

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POPULAR MISCELLANY.

Natural Purification of Polluted Streams.—The growing population of the many cities which discharge their sewage into rivers gives increasing importance to the question how great a degree of pollution is allowable in a stream of given flow, the water of which is to be used lower down for domestic or for manufacturing purposes. Mr. Rudolph Hering says that oxidation and decomposition of sewage matter was for a long time thought to be the main cause for the clarification of polluted rivers. To-day it is known to be but a minor cause compared with dilution and subsidence; and if the sewage is discharged in a fresh condition into a stream of water, its destruction is in part due to fish and other aquatic animals. Some of the refuse from stock-yards is disposed of, no doubt, in this way. Most of the decomposition, or oxidation as it is usually termed, of sewage is effected by the myriads of microscopic plants, microbes, or bacteria contained in both air and water, which at once seize upon the dead organic matter. For purifying the sewage discharged into a river, oxidation can be depended upon only to a limited extent, because of the comparative slowness with which it takes place. Subsidence of the heavier matter tends to clarify it before it flows many miles; dilution with a sufficient quantity of clean water prevents an offensiveness almost at once; but oxidation requires many days under continuous aëration of the river. From a comparison of data in regard to the actual purification of polluted streams we may draw the following inference: Rivers not to be used for water-supplies, but to be inoffensive to communities residing a few miles below, to remain fit for ordinary manufacturing purposes, and to sustain the life of fish, may receive the sewage from one thousand persons for at least every one hundred and fifty to two hundred cubic feet of minimum flow per minute, supposing that natural subsidence of the heavier matter takes place immediately below the town discharging the sewage. Beyond the above limit it appears to be advisable to resort to land or other filtration, or to chemical precipitation. But the whole subject needs further investigation.

The Nebraska City Pontoon Bridge.—Colonel S. N. Stewart, of Philadelphia, has recently built a pontoon bridge for ordinary traffic across the Missouri River, at Nebraska City. It is 1,074 feet long, 24½ feet wide, and consists of a flooring laid upon boats which float upon the river and are securely anchored. The city has held a franchise for such a bridge for twelve years, but the project has been opposed by persons interested in steamboats plying on the river. Many predicted that the attempt would fail, for the Missouri River has a swift current, which here attains about its highest velocity, and large numbers of logs and trees are constantly drifting in the stream. These, however, are carried under the floats without doing any damage. In the channel of the river the bridge makes a V, pointing down stream, which is the draw. To open the draw, the connections at the point of the V are cast off, and the current swings the two sections apart, leaving a free opening 528 feet wide. It is the widest draw in any bridge ever built. The ends of the section are connected by a sunken steel-wire cable, and the draw is closed by winding this up on a capstan, worked by one man. There is a pontoon bridge across the Mississippi River at Prairie du Chien, the draw of which requires a powerful engine to close it. The bridge is to be removed each winter when ice covers the river. Both the pontoon bridge and a crib-work structure 1,050 feet long which crosses a second arm of the river were built in twenty-eight days, at a cost of about $18,000. For the spring floods it is proposed to greatly increase the strength of the steel anchoring cables. The bows of the boats are to be sheathed with iron, and the bottoms are to receive an extra planking of oak. A railroad bridge of steel crosses the river near the pontoon bridge. This was built between December, 1887, and June, 1888. Heretofore pontoon bridges have been little used except as a temporary expedient for military purposes; but their cheapness, and the satisfactory character of the draw and other details in the form just described, bespeak for them a more extended use.

Somali Traits.—The Somalis, as represented by Mr. F. L. James, who has traveled among them, are a curious people, hostile to Europeans, treacherous, "marauding, semi-civilized half-castes, offshoots of the great Galla race, allied to the Caucasian type by a steady influx of pure Asiatic blood. They are Mohammedans, but the rites of their religion sit loosely upon them. Although their trust is in Allah, they have been known to ask where he can be found, as some of them would like to catch him and spear him for having laid waste their homes and killed their wives and cattle. Yet they let off sudden prayers with great fervor during moments of anxiety." The hire of camels and drivers to the traveler was ratified by an oath that, if the man failed to keep the terms of the contract, he would divorce his wife. Mr. James had to engage women-servants, because the men refused to build their own mat-huts or do any cooking. None of their fathers had done this, they argued, and were they to do the work of women the tribes through which they passed would despise them. At one place the people believed the caravan had descended from the heavens, and this was confirmed when Mr. James and the others began to smoke. "The pipe was part of ourselves, for how else could our mouths blow forth clouds, which would of course bring down rain?" The author explained that these clouds were not "water-bearers," but were due to plants lighted by harmless fire-makers," and to prove this one of the party struck a match and lit a fresh cigarette. This caused further bewilderment. The match had produced lightning, and of course the cloud could produce thunder; so the travelers were "storm-makers."

Healing of the Broken Bones of Birds.—It is not often that doctors are able to observe a broken bone almost in the very act of healthful healing, as has recently been the privilege of Dr. R. W. Shufeldt. He obtained on the same day a red-tailed hawk and a turkey-vulture which had been shot while high in the air with a 0·45 caliber government carbine; the ball in the former case passing clear through the chest, and in the latter case breaking in two the radius and the ulna. The hawk's wound could not be discovered, and the bird was apparently whole and vigorous. When killed and dissected, three weeks afterward, it was found that all of the costal ribs and the scapula had been broken across, but were now substantially healed. The ribs had individually made a good union and there was no anchylosis among them, and the blade of the scapula, though not perfect, was in essentially as good a condition as ever; the whole constituting a case of "a fearful wound with a truly magnificent recovery." The buzzard, besides having been shot, had been kicked about by the soldiers, "and was more dead than alive." It had recovered, and could fly well in about a week, when it was killed. The union of the bones was complete and firm, and a mass of callus was being rapidly absorbed at the sides of the fracture, while the bones had remained practically straight. From this and other cases within his experience, the author is convinced that, in case of fractures of the bones of the wings in birds, the good unions that result with hardly any deformity or shortening are largely due to the material assistance afforded by the quills of the primary and secondary feathers, which act as splints. Were this not the case, and if deformity ensued, the bird would be crippled in its power of flight, or deprived of it.

Food and Economical Plants of Abyssinia.—The most important of the food-plants of Abyssinia is the *taff* (*Poa Abyssinica*), a cereal bearing grains as small as a pin's head, from which the general bread is made. An inferior black bread is made from a kind of millet that grows in low grounds. Roasted flax-seed is sometimes eaten. The flower-stock of the plantain, cooked with milk and butter, is very tender, has the flavor of new bread somewhat underdone, and is an excellent dish. From the leaves of the *ensete* mats are made. The *ceca*, an asclepiad, furnishes a tough fiber, which is used in making cordage and twines. Other fibers, for various uses, are furnished by the bark of the *Calotropis gigantea*; and the tender leaves newly pulled from the stipe of the doum-palm are wound into all kinds of matting and basket-ware. The powdered seed of a large tree called *herebera* (*Milettia ferruginea*) is thrown into the water to stupefy fish, and makes it more easy to catch them. The chief articles of export are calves' hides, salted and dried, beeswax, ivory, tamarinds, ostrich-feathers, gutta-percha, gum arabic, mother-of-pearl, leopard-skins, musk, honey, and tobacco.

Interest in Reading.—The primary object of ordinary reading or study, Mr. Balfour holds, in his rectorial address at St. Andrews, is the enjoyment to be obtained by the possession and acquirement of knowledge. Knowledge is most easily attained in those subjects which we like most and take most interest in; and by that principle we should be directed to the kind of reading which we should take up. By the same principle we should not try to read the books on the list of the hundred or so best, merely because they are on the list; but when our interest is fixed on a particular line, the list is good to refer to for the best books bearing upon it. What interests the ordinary man at one time does not interest him at another; but "his interests change with the changes that are going on around him in the world. He sees some natural curiosity, reads something in the newspapers, hears of some incident or character in history, or goes to some place which awakens his interest and attention, and induces him to read. If the ordinary man, then, is to read what interests him, he is pretty sure to read widely, and therefore necessarily, since life is short, superficially. . . . Now, can it be said, that the man who reads like this, with freshness and vigor, eager to find out something, to get light on a subject dark to him before, will not get more knowledge, and so benefit himself vastly more, than the man who, with slow and painful steps, heavily plods through a list of books, though that list has on it all the masterpieces of creation?"

House-top Summer-Resorts.—A plan to make our house-tops useful is sketched by Dr. Gouverneur M. Smith, in a paper on "Wasted Sunbeams—Unused House-tops." The Oriental has no difficulty in the matter; he lives on the top of his house a considerable part of the year, and builds his roof with an especial eye to that sort of occupation. Why may not we? By pitching our tents upon them, or by taking them as they are, except that the roof-coverings would have to be made more solid, we might make our roofs comfortable sojourning-places and inexpensive summer health-resorts. "Roofing," says the author, "can be contrived suited to this climate, and enduring as pavement. A pleasure resort might ornament each residence, its limits bounded by the area of the dwelling; neighborly consent could widen the range, turf and flowers brightening the plan. Iron-framed and glass-inclosed rooms or cupolas could be added, which would prove useful during all seasons, artificial heat tempering brumal inclemency. If such adaptation of house-tops would be an advantage to the affluent, who can escape city life during the summer, how much greater advantage would be secured to the tenement-house districts! . . . For the higher graded tenement-houses, such fresh-air facilities would be hailed with delight by the inmates. The proximity of open breathing-places to their rooms would endear their humble homes. Summer moonlight evenings could have a new aspect; and again, round a family lantern, groups might gather to read, sew, or engage in games, and thus a home-felt pleasure could quiet restless spirits, craving questionable or illicit amusements. More true enjoyment might be observed in such groups than on the piazzas of fashionable resorts. Landlords could arrange for the periodical sweeping of roofs, as well as of the halls and stairways, and, among a very large class of the respectable poor, pride would stimulate to a tidy and decorative care of their home parks." By a little alteration in structure the upper stories of houses, now stuffy places enough, could be made light and airy, and attractive as resorts or play-rooms in inclement weather. This recalls the papers contributed by Mr. Bunce in "Appletons' Journal" several years ago, in which a similar utilization of the roofs of the tall houses just then coming into fashion, or their conversion into gardens, was advised and illustrated with pleasing descriptions of what might be.

Adolf Sutro's Water-Power.—Mr. Adolf Sutro's aquarium at San Francisco, though at a higher level than the ocean, is fed by sea-water in sufficient quantities to furnish a strong constant stream by the action of natural forces only. How it is done has been told, in the California Academy of Natural Sciences, by Mr. Theodore H. Hittell, who indicates also what may be a new economical power. The aquarium is on the lee side of a jutting rock. Through this rock, and leading out to its exposed face, is a short tunnel, while on the face of the rock most exposed to the rollers of the ocean is an excavated hollow place or basin, the bottom of which is several feet above high-water mark. As the rollers come in they dash violently against the face of the rock, rise in mingled water and foam to a very considerable height, and splash over into the basin. The water thus caught in the basin does not fall back into the ocean, but runs through the tunnel into the aquarium and maintains its high level. Between that level and the level of the ocean in the cove, where there is no rock to dash against and no splashing, there is a fall, as indicated by the running stream, of several feet—enough to furnish very valuable water-power. The principle of gaining a head of water thus applied may obviously be made of great importance at many points along the coast. Though the main body of water to be caught is thrown up only during high tide, there is hardly any limit to the amount that may be thus secured, provided the basin is large enough and not too elevated.

Fast Railway-Trains.—Some remarkably fast time has been made recently by trains between London and Edinburgh, in consequence of a rivalry between the Northwestern and the Great Northern Railways. The journey formerly took nine hours, but last summer the former road reduced the time to eight hours and a half. Its rival then made it eight hours, and, on August 6th, the Scotch Express, on the Northwestern, covered the distance in eight minutes less. The times of the runs made without stopping on this trip were: Euston to Crewe (158 miles), 2 h. 56 m.; Crewe to Preston (52½ miles), 51 m.; Preston to Carlisle (90 miles), 1 h. 38 m.; Carlisle to Edinburgh (100½ miles), 1 h. 45 m.; the average speeds attained being the highest yet reached. On the second day of the accelerated service, this train, consisting of an engine with six coaches, made the run from Crewe to Preston in fifty minutes, and that from Preston to Carlisle in ninety minutes. This is claimed as beating every previous record.

Sagacity of the Blood-hound.—The blood-hound is declared by Dr. Gordon Staples, from his own somewhat wide experience, to be one of the most sagacious of all dogs. "His wisdom when quite a puppy is sometimes astonishing. When only six months old, he will often show to his master that he has already come to the conclusion that life is real and earnest, and not meant merely to romp and play in. I have had a puppy at this age take me quite in charge, as it were, giving himself all the airs and manners of a dog of seven years old, and going on watch at nightfall as serious as a sentry in an enemy's country. He would look up in my face as much as to say: 'There's nobody in this wicked world worth a thought except you and me, master, and you don't count as far as defense goes; if you please, I'll do the watching for both.' As a rule, the blood-hound is most docile and willingly affectionate. He can be trusted with children: so much so, that a boy may safely do duty as the 'hunted man' when the hound is being trained in hill or forest. The animal is nevertheless suspicious of the motions of strangers; he therefore makes a most efficient guard either to person or to property." Both scent and sight are remarkably well developed in the blood-hound; the animal is beautifully formed all over for hard work, but does not excel in speed. In olden times he was called the "slow-hound," among other names, and when the trail was perceptible, even to human senses, the dog was taken on horseback to save time. Great value is put upon the hound's up-bringing and general treatment when not on duty. "If the creature has been reared and trained by a fool, and under the influence of fear—if he be not well kept, properly bedded, exercised, and fed, and allowed the companionship of man, he is certain to develop more or less of nervous debility, and ten to one will go wrong at the critical moment. . . . Some people doubt the possibility of dogs tracking a criminal through the streets and lanes and busy thoroughfares of a crowded city. They speak of cross-scents; but in doing so they speak of what they do not understand as well as—the blood-hound does. He has got the right scent at the right place, and, if he is the right sort of dog, he will stick to that and no other. Besides, it has been done over and over again."

Diet and Disease.—Dr. A. Hunter's new cook-book—"Culina Famulatrix Medicinæ; or, Receipts in Modern Cookery, with a Medical Commentary"—contains much plain speaking with reference to certain dishes which are supposed to contribute to the increase of the business of doctors. A certain giblet-soup is described as containing "a considerable amount of gout and scurvy." A mock-turtle soup is pronounced "a dangerous dish, and will soon bring a man to his crutches"; a second kind is denounced as "a most diabolical dish, only fit for the Sunday dinner of a rustic who is to work the six following days in a ditch-bottom"; and of a third, the author observes, "there is death in the pot." Other dishes of equally elaborate composition, and to the lay view as indigestible, are well spoken of; whence it may be inferred that the author is as prejudiced as scientific.

NOTES.

Dr. H. A. Hare, of the University of Pennsylvania, has issued, through P. Blakiston, Son & Co., Philadelphia, his essay on "Mediastinal Disease," to which the Medical Society of London awarded the Fothergillian medal for 1888.

A curious story of foster relationship between a wood-duck and a hen is told by a Mr. Palmer. The duck was hatched along with a brood of chicks from an egg that had been placed under the hen. It was attended as well as her other chicks by the mother, and reached adult age. Then, when the hen brought out another brood of chicks, it kept in close attendance, much to the hen's annoyance, and with occasional resultant fights. Finally, the duck drove away the hen and took exclusive care of the chicks during the day, only giving them up at night.

A new oil-burning light, called from its inventor the Doty light, is said to be well suited for lighting all places where brilliant illumination, without dark shadows, is required at moderate cost and without elaborate preparation. In it oil is forced by compressed air through a tube which has been formed into a double coil. The coil is heated, so that the oil is vaporized in passing through it, and, becoming ignited at the burner, issues in a brilliant flame. The pressure of the air is kept up by a few occasional strokes upon a hand-pump. Three sizes of the light are placed upon the market—300, 500, and 1,000 candle-power. The inventor claims for it numerous advantages resulting from its being self-contained, self-generating, and portable.

The greater prevalence of diphtheria, small-pox, and scarlet fever in the cold seasons of the year is explained by Dr. H. B. Baker as resulting from the tendency in those periods to catarrhal inflammations of the respiratory tract. This is also exemplified in the prevalence of influenza, bronchitis, and tonsillitis. The cause of these forms of inflammation may be found in the retention of non-volatile salts in the mucous lining of the air-passages.

The land of the salt-district in Cheshire, England, is gradually undergoing subsidence in consequence of the pumping up of the brine which is produced by the solution of the rock-salt far below the surface. As this brine is removed, fresh water takes its place, and this reacts upon the rocks, forming new brine, which is pumped up in its turn. And so the process goes on year after year, with constant removal of the props of the earth.

Experiments have been made by Mr. Saunders, of the Experimental Farms, Ottawa, in the cultivation of grains from the extreme north of Europe, for the purpose of securing varieties that will ripen in the shortest Canadian summers. Wheat from Lake Ladoga, latitude 69°, ripened from ten to fifteen days earlier than other varieties in cultivation; a difference sufficient to insure its maturing soon enough to escape the earliest autumn frosts. This wheat yielded nineteen-fold, and was of satisfactory quality. Onega wheat, from latitude 62°; barley, from latitude 66°; and barley and rye from latitude 67°—or from the extreme northern limits at which cereals are grown in Europe in a continental climate—are on trial.

How dependent schools were, and to some extent still are, on books as contrasted with individual power, is illustrated in the life of the late Prof. Thomas Hill Green. The first time he competed for the Queen's medal at Rugby he complained that, though the judges liked his essay the best, they gave the prize to another boy, "because his essay showed more labor, i. e., came out of thirteen books instead of his own head." In the next competition he was successful, contrary to his own expectation, for the subject was one for which, he says, he had "to consult a variety of forty authorities, which I never can succeed in doing well; I always find that, if I cram myself with the ideas of others, my own all vanish."

A new life-saving jacket—Mr. J. Johnson's "Eclipse Life-Belt"—consists of twenty corrugated metal tubes joined with durable webbing, so adjusted as to give the tubes a vertical position on the chest and back. It has a supporting power of thirty-two pounds in fresh water. The belt can be readily adapted to the side of a ship's boat to render it unsinkable.

A sufferer from sleeplessness avers that he has found a remedy for his trouble by holding his breath till discomfort is felt, and repeating the process a second and a third time. The "Lancet," while it admits that this method may produce the desired effect, mentions some dangers connected with it which would make its general adoption unadvisable. Another victim of insomnia, regarding the affliction as a consequence of mental worry and deficiency of exercise and fresh air, advises hygienic living, moderation in eating and drinking, and abstinence from stimulants. In dealing with severe nervous irritation from mental or physical work, he has found a daily rest an almost essential prelude to sleep at night. This advice is pronounced sensible.

M. Des Cloizeaux has become President of the French Academy of Sciences; and M. Hermite has been chosen Vice-President, to become President in turn in 1890.

The Medico-Chirurgical Society of the Canton of Berne, Switzerland, has offered prizes for the best and next best essays on the question, "Up to what point is there ground for entertaining the criticisms which have been made from a medical point of view on the intellectual overpressure of children in the schools of a Swiss territory?" Essays of a purely theoretical character, and compilations from books embodying facts which the competitor has had no means of personally examining, will not be considered. The essays may be in French or German.

Mr. Im Thurm noticed, in the course of his explorations in British Guiana, that tamed animals of many species—parrots, macaws, trumpeters, monkeys, toucans, etc.—were kept in some of the Indian villages. They take the place of currency. These Indians, not having yet risen to the civilization of a protective system, carry on special occupations in their different villages: thus in one they spin, in another make mats, in a third pottery, in a fourth cassava-mills, etc. Some of the trading is done by barter between the villages, and the balances are adjusted with this living "currency."

The seventieth birthday of Prof. Von Pettenkofer—the father of hygienic science, as the Germans call him—was celebrated in Munich on the 3d of December, with enthusiastic demonstrations by the students, and visits and testimonials from scientific and medical men of all parts of Germany. Among those who thus honored him were the civic dignitaries of Munich; the National Liberal party; representatives of the royal family; numerous scientific and medical societies and universities at home and abroad; the Prussian Minister of Education; and old pupils. The students had a grand torchlight procession on the evening of the 5th, which was addressed by Pettenkofer, and ended with a shout and a song.

A compendium of transoceanic weather observations—from Walfisch Bay, South Africa; Hatzfeldhafen, New Guinea; and the coast of Labrador—has been published by the "Deutsche Seewarte." The last observations were made by missionaries on the initiative of the "Seewarte." Such observations will hereafter be regularly published in yearly volumes.

Among the more important papers in the "Year-Book" of the Italian Meteorological Society for 1887 are those of Ferrari on the relations of sun-spots to earth-magnetism, of Pagliani on the relations of cholera and weather, and of Roster on those of the air and health. The "Year-Book" also contains a bibliography of all Italian works on meteorology that appeared in 1886.

An Anthropological Congress is to be held in Vienna in August.

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